STUDENT CORE TEXT

ARMY JROTC

LEADERSHIP EDUCATION & TRAINING

Geography and Earth Science

US Army Cadet Command - FT. Monroe, Virginia

HEADQUARTERS, DEPARTMENT OF THE ARMY

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Unit 5: Geography and Earth Science

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THE GLOBE

LESSON 1: THE GLOBE — AN OVERVIEW

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INTRODUCTION

In order for you to be a better citizen, it is important that you know about the world around you. How often while watching a news program, have you heard the name of a country and wondered where it was? Or while enjoying a movie filmed in a beautiful location have you thought that you would like to visit there someday? An understanding of the globe can help you readily identify a location and provide you with a visual or mental picture of it.

An overview of the **globe** will give you a basic understanding of the world in which you live. This overview will include the seven **continents**, four **oceans**, two **poles**, as well as **longitude** and **latitude** lines.

A GLOBE DEFINED

A *globe* is a sphere-shaped model of the earth. It is a representation of the Earth as it really is, round or like a ball. Looking at photos of the earth taken from space, you will only see half of the earth, or one **hemisphere**. A globe shows the whole earth. It shows the water and land formations on the earth's surface and helps you to understand natural events such as day and night and the seasons.

THE CONTINENTS

Continents are the seven large landmasses on the planet. It is believed that there existed only one continent over 225 million years ago. This continent slowly broke apart, shifted and drifted over millions of years until it assumed the shapes and positions of the seven continents that we recognize today. The seven continents from largest to smallest are Asia, Africa, North America, South America, Antarctica, Europe and Australia.

Asia is the largest continent in both size and population. It covers almost a third of the world's land area (16.9 million square miles) and has about three-fifths of its people (3.7 billion). It has 49 independent countries. Asia extends from Africa and Europe in the west to the Pacific Ocean in the east. The northernmost part of the continent lies within the frozen Arctic. In the south, Asia reaches into the steaming tropics near the equator.

Asia has some of the world's longest rivers, largest deserts, and thickest forests and jungles. The highest and lowest places on the earth are in Asia. Mount Everest, the highest, rises 29,028 feet above sea level and is along the Nepal-Tibet border. In contrast the Dead Sea shore, located between Israel and Jordan, is the world's lowest land, lying about 1,310 feet below sea level.

Africa is the second largest continent in area and population. Africa covers about one fifth of the world's land area (11.6 million square miles) and is home to one-eighth of its people (824 million). The continent is an immense plateau, broken by a few mountain ranges and bordered in some areas by a narrow coastal plain. It is a land of striking contrasts and great natural wonders. Tropical rain forests inhabit western and central Africa. The world's

largest desert, the Sahara, stretches across northern Africa. It occupies an area almost as large as the entire United States. Africa also has the world's longest river — the Nile. It flows more than 4,000 miles through northeastern Africa. Much of the rest of the continent is grassland located in eastern and southern Africa.

North America is the third largest continent in area (9.3 million square miles) compromising about one-sixth of the world's land area. It extends from the Arctic Ocean in the north to South America in the south. It ranks fourth among the continents in population. (Asia, Africa, and Europe are larger in population.)

The continent is roughly triangular in shape with the Arctic, Atlantic, and Pacific Oceans bordering its three sides. At its northern end, North America stretches more than 5400 miles from Alaska's Aleutian Islands to the Canadian province of Newfoundland. At the southern end of the continent, the narrowest parts of Panama are only about 30 miles wide.

South America is the fourth largest continent in area (6.8 million square miles). Only Asia, Africa, and North America are larger. It ranks fifth among the continents in population (346.9 million). Asia, Europe, Africa, and North America all have more people. South America covers about 12 percent of the world's land area and has about 6 percent of the total world population.

South America has nearly every type of landscape and climate, however, is only 600 miles from Antarctica. The world's largest tropical rain forest grows in the Amazon River Basin. This basin occupies about two-fifths of the continent. By contrast, the Atacama Desert in northern Chile is one of the driest places in the world. Also to be found are snowy peaks and active volcanoes rising along the crest of the lofty Andes Mountains of western South America. Not to be forgotten are the rolling grasslands that stretch endlessly through much of Argentina and Venezuela. South America's varied landscape also includes spectacular waterfalls, huge lakes, and rocky, windswept islands.

South America is almost totally surrounded by water. The Caribbean Sea lies to the north and the Atlantic Ocean borders South America on the northeast and east. To the south, the Drake Passage separates South America from Antarctica. The Pacific Ocean is located on the west coast. South America borders land only at the Isthmus of Panama. This narrow strip of land links Central America with Colombia, in the northwestern part of South America.

Antarctica is an ice-covered continent located in the South Pole — the earth's most southerly region. Its nearly barren land forms the coldest and iciest region in the world. It is slightly colder than the region around the North Pole because the North Pole is located in the Arctic Ocean. The South Pole lies near the center of the Antarctic continent, on a high windy plateau of ice and snow. Antarctica's deepest ice is more than 10 times the height of the Sears Tower, one of the world's tallest buildings. Antarctica covers about 5.4 million square miles, making it larger in area than either Europe or Australia. But, it would be the smallest continent if it did not have its icecap. This icy layer which averages 7,100 feet thick increases Antarctica's surface area and also makes Antarctica the highest continent in terms of average elevation.

Stormy waters of the Atlantic, Indian, and Pacific Oceans isolate Antarctica from the other continents. The world's lowest temperatures have been recorded in Antarctica. Ice and snow cover 98 percent of the continent. Underneath the ice, Antarctica has mountains, low-

lands, and valleys — much like the landforms of other countries.

Europe is one of the smallest of the world's seven continents in area but one of the largest in population. It covers an area of about 4 million square miles and has a population of 707.8 million. Only Asia and Africa have more people. About one-eighth of the world's people live in Europe. Europe extends from the Arctic Ocean in the north to the Mediterranean Sea in the south and from the Atlantic Ocean in the west to the Ural Mountains in the east. Because Europe and Asia occupy the same landmass, they are sometimes collectively called Eurasia.

Australia is the only country that is also a continent. As a country, Australia is the sixth largest in the world. As a continent, however, it ranks smallest in size It is a stable landmass that lies between the Indian and Pacific Oceans. The northern third of Australia lies in the tropics and is warm the year round. The rest of the continent has warm summers and cool winters. About a third of the country is desert. Since it lies south of the equator, its seasons are opposite those in the Northern Hemisphere.

OCEANS

Did you know that the Ocean is one continuous body of water interrupted by landmasses? It has been assigned four different names based on where it is divided by these landmasses: *Pacific Ocean, Atlantic Ocean, Indian Ocean and Arctic Ocean.*

The Pacific Ocean is the largest and deepest of the four oceans and covers a third of the globe, over 64 million square miles or 165.8 billion square kilometers. Its average depth is 12, 900 feet. It is so large that all seven continents could fit in it and there would still be room for one more continent the size of Asia. It separates North and South America from Asia and Australia.

The Atlantic Ocean is the second largest body of water on the globe covering 33 million square miles or 867.7 billion square kilometers. It is continually widening and has an average depth of 11,700 feet. The Atlantic Ocean is bordered by Europe and Africa on the east and by North America and South America on the west.

The Indian Ocean is the third largest ocean and covers an area of about 28.3 million square miles or 73.3 billion square kilometers. At 12,600 feet deep, it is deeper than the Atlantic Ocean but smaller in size. It is the only ocean that is bordered by land on the north rather than water. On the eastern border is Indonesia and Australia. Africa is to the west and Antarctica to the south.

The Arctic Ocean is the smallest and shallowest of the four oceans. It is about 5 million square miles or 13 million square kilometers and averages about 4,000 feet deep. It is located at the top of the globe and is bordered primarily by northern Asia, Europe, and North America.

These four oceans are salt water and cover more than seventy percent of the earth's surface. They contain the highest mountain range, deepest valley, and some of the most unusual animals on earth.

POLES

The points on the globe representing the northernmost and southernmost points of the earth are the North Pole and South Pole. They are located on each end of the earth's imaginary axis. The areas around them are sometimes referred to as **Polar Regions** because they are around the North and South Poles. The North Pole is located in the Arctic and the South Pole is located in Antarctica. They are the coldest places on earth — frozen deserts covered in ice all year long. The North

Pole is the farthest point north. When looking down at a globe of the earth, it is shown at the top. When you look down on a globe of the North Pole, the landmasses of North America, Europe, Asia, and even parts of Africa can be seen. The South Pole is the farthest point south. A map centered on the South Pole features the continent of Antarctica surrounded by ocean. Because it is over land instead of water, the Antarctic region is much colder than the Arctic. The closest continents visible from this vantage point are South America, Africa, and Australia.

LONGITUDE AND LATITUDE

The Ancient Greeks used observation and mathematics to determine that the earth was round and not flat. That was nearly 2000 years before the earth could be photographed from space. They also developed a method for locating places on the earth. They came up with a system to divide the globe into 360 segments, called **degrees.** The imaginary vertical lines used to divide these parts are the longitude lines or **meridians**. They run from the North Pole to the South Pole and are equal in length. The imaginary horizontal lines on the globe are the latitude or **parallel** lines. These lines are parallel to each other and form complete circles around the globe. The horizontal lines of latitude and the vertical lines of longitude are further broken down into degrees, minutes, and seconds so that any point on earth can be located using the two lines that meet at that point on a globe.

In 1884, the **prime meridian,** or the longitude line numbered 0 degrees, was established at an international conference. It is the starting point for measuring distances east and west around the globe. The prime meridian at 0 degrees and the 180^{th} meridian or longitude line on the opposite side bisect the globe into eastern and western halves. Longitude lines east of the prime meridian are numbered 1 degree to 180 degrees east (E). This part of the earth is the eastern hemisphere. Longitude lines west of the prime meridian also numbered 1 degree to 180 degrees west (W) represent the western hemisphere. The prime meridian passes through the Royal Naval Observatory in Greenwich, a section of London, England.

The **equator**, or 0 degrees latitude, is an imaginary line that circles the globe at its widest point halfway between the North Pole and South Pole. The equator is the longest latitude line or parallel. Latitude is measured from 0 degrees to 90 degrees from the equator to the North Pole. This part of the earth from the equator to the North Pole is known as the **northern hemisphere**. Latitude is also measured from 0 degrees to 90 degrees from the equator to the South Pole. This part of the earth from the equator to the South Pole is known as the **southern hemisphere**. When any latitude line is given, it must be stated in north or south latitude.

CONCLUSION

Understanding the world around you will help you to be a better citizen. You are not isolated no matter where you live: in a small community, town, city or major metropolitan area. Your personal involvement and actions as a citizen can and will have a direct impact on the globe — the world around you and the world of tomorrow.

***

MAPS, MAP READING, AND LAND NAVIGATION

LESSON 1: INTRODUCTION TO MAPS

PURPOSE

Knowing how to read and understand maps are valuable skills that can strengthen your awareness of the world around you. Your effective use of maps requires a basic understanding of them, their scales, symbols, and colors. The first lesson in this chapter introduces you to this information and explains how to **orient** a map by matching **manmade** or natural features with map symbols. The next lesson of this chapter shows how this basic information compares to what you find on **topographic maps**.

bar scales
contour lines
contrast
elevation
intermittent
landforms
legend
man-made
marginal information
orient
prominent
relief
terrain
topographic maps

INTRODUCTION

Maps are in common use throughout the world today. For instance, when a family takes a vacation, a map is used to guide the driver from one city to another. The airline pilot and the sea captain use special charts or maps from which to navigate. Rarely do experienced navigators become lost. Instead, they apply their map reading abilities to read, understand, and use maps effectively.

Have you ever found yourself on the wrong road or in the wrong neighborhood? If you asked for directions in this situation, were you told, "Go right," or "Turn left"? After following these directions for a few blocks, the question arises, "Turn right ... where?" These types of situations call for map reading skills.

DEFINITION OF A MAP AND MAP READING

A map is a line drawing of a portion of the earth's surface, as seen from above. Obviously any attempt to plot each feature to its exact shape and scale would result in a map too big to read. Therefore, maps are drawn "to scale" with each set measurement on the scale representing a set amount of the earth's surface.

In general, maps provide information about the existence and location of man-made and natural features; show distance, **elevation**, and different types of **landforms**; and depict man-made and natural features by the use of symbols, lines, colors, and forms or shapes.

There are many different types of maps. However, the most common types are:

- city or state road maps
- geographic maps/atlases
- topographic maps.

City or state road maps, also known as tourist maps, provide information on street names, important buildings, route numbers, distance, transportation centers. In many cases, they include the location of recreational or historical areas, as well.

Geographic maps show an overall view of the mapped area in relation to climate, population, **relief**, and/or vegetation. An atlas is a collection of geographic maps of regions, countries, continents, or the world. These maps are generally not as accurate as city or state maps. And compared to topographic maps, their accuracy is significantly inferior, therefore, they should be used for general information only.

Topographic maps show **terrain** and landforms in a manner which can be measured. They also show the horizontal positions and elevations of these features. Elevation on these maps is normally indicated by vertical **contour lines**. Topographic maps are the ones most commonly used in the military. Beginning with the next lesson, we will examine topographic maps in detail and will use them throughout the remainder of this unit so that you can begin to understand how to read and use them.

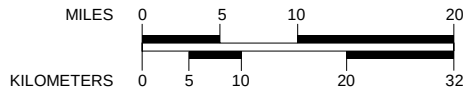
ROAD MAPS

MARGINAL INFORMATION

You can compare a map to any piece of equipment — before you use it, you must first read the instructions. Most mapmakers place the instructions on a map (known as the **marginal information**) around the outer edge of a map. All maps are not the same, so it is necessary to read the marginal information carefully every time you use a different map. The following discussion describes and illustrates the most commonly used elements of marginal information that are found on road maps.

- Sheet or Map Name. Whenever possible, a map is named after the most **prominent** cultural or geographic feature in that area (For example, Orlando or the Official Transportation Map for the State of Florida). Although the most prominent feature on the map may be a state or other large geographical region (for example the Mid-Atlantic States), the map sheet normally contains numerous inserts of smaller sections in order to show them in more detail. These inserts can be found around the margin or on the reverse side of the map sheet.

- Bar Scales. **Bar scales** are special rulers used to measure ground distance on a map. Although these scales may vary with each road map, the most common units of measurement are miles and kilometers. Shown below is an example of a scale used on the Official Transportation Map for the State of Florida.



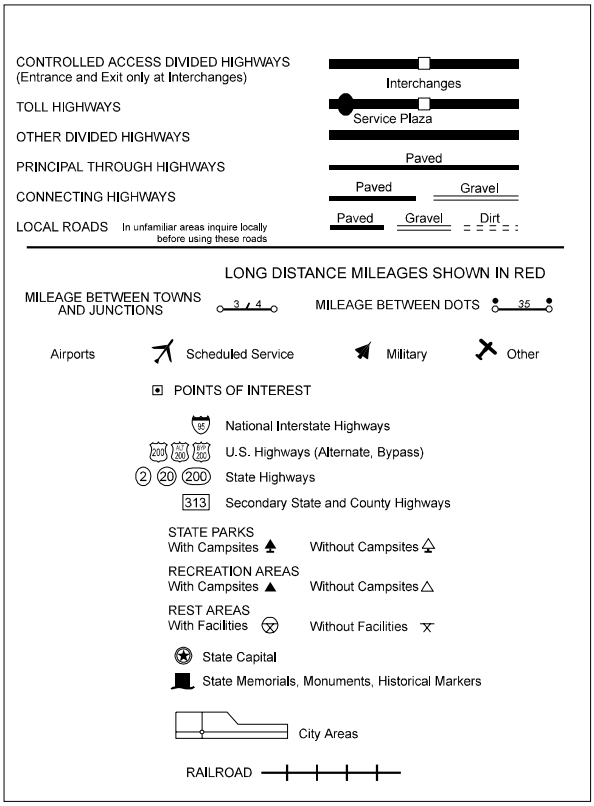
One Inch equals 12 Miles or 19 Kilometers

- Printing Note. This note indicates the agency responsible for printing the map. The printing date determines when the map information was obtained, not when the map was printed.

- Legend. The **legend** is part of the mapmaker's dictionary. It is a shorthand method of illustrating and identifying mapped features using symbols to show some of the more prominent features on the map. These symbols are not the same on every road map.

MAP SYMBOLS

Since all features on a map cannot represent their true position and shape, map-makers must use symbols to represent these features. These symbols are made to look as closely as possible like the actual features themselves as they are seen from above. The legend indicates the meanings of the symbols that are used on a map. A few of the commonly used symbols that you will find on road maps are identified below.



⇒ Roads: Indicated by parallel or solid lines. Thickness and color of these symbols indicate the road size.

⇒ Interchanges: Indicated by a heavy solid line for major access roads and parallel lines for intersecting secondary roads. Legends also illustrate full, partial, and no access at these interchanges.

⇒ Railroads: Commonly shown by single or parallel lines with horizontal tick marks.

⇒ Buildings: Symbols for buildings may vary from map to map according to the purpose of the map or building. Schools and churches are commonly represented by a solid square with a flag or cross affixed. Hospitals may be shown by a cross. Universities and colleges may sometimes have a special symbol as a point of interest.

⇒ Points of Interest: Indicated by a special marking and its name; for example, a historical marker.

⇒ Airports: Normally shown by a picture of an airplane.

⇒ Water Features: Normally shown in blue and take the approximate shape of the feature.

⇒ Special Features. Significant natural features (forests, recreational areas, national monuments, etc.), military reservations, or Indian reservations are normally highlighted with a specific color and do not have a standard shape. Many road maps also have a chart indicating the services that are available at the recreational areas and parks shown on the map.

You may also find the following symbols on road maps that can provide helpful information to you when using the map.

⇒ Route Markers: Represented by a shield or some other shape containing the number of the road in its center. Although the map may show these route markers with white numbers and/or letters on a black shield or shape, the actual colors of the signs as seen on the highway are indicated below.

Interstate Highways

- Principle Routes: Red, white, and blue signs with one- or two-digit numbers. East-west routes have even numbers (I-4 or I-70), whereas north-south routes have odd numbers (I-5 or I-95).
- Loop or Belt Routes: Red, white, and blue signs with three-digit numbers; the first number is always even (I-295). These routes circle or bypass major cities.
- Spur Routes: Red, white, and blue signs with three-digit numbers; the first number is always odd (I-580). These routes lead into major cities.
- Business Routes: Green signs marking routes from principal, loop, or belt highways that go to or through cities.

⇒ Boundary Symbols: Shown as broken or **intermittent** lines which vary in pattern to denote different boundaries (for example between counties, states, or time zones).

⇒ Mileage Markers: Shown between towns and road junctions or between dots with the mileage indicated in red or black (see the example in the illustration on the preceding page). State and regional maps also show long distance mileage between major cities by printing that information in red (with red directional arrows), and centering it between the two cities. An example of this long distance mileage indicator may appear as follows:

TAMPA
199 Miles
320 Kilometers
WEST PALM BEACH

⇒ Official Highway Mileages: This chart shows the actual ground mileage between the major cities that are located on the map.

⇒ City/Street Names: This information lists alphabetically (wherever space permits on the map — including on the reverse side of it — and printed adjacent to its corresponding feature) the names of cities on state and regional maps and the names of streets on city maps. Beside each city or street listing is a letter/number code (for example, D-9). Along the outer edge of the margin are letters ranging from "A" to "P" (or beyond) and numbers ranging from "1" to "15" (or beyond). Note that the letter "I" is usually omitted so as not to be mistaken for the number "1."

The following example shows how to locate features on a road map using this letter/number code. **Note:** For this example, our map sheet will have the letters along the vertical (left and right) edges of the margin and the numbers along the horizontal (top and bottom) edges. To find the feature at D-9, use a finger on one hand to locate the letter "D" — it should be close to the top left or top right edges of the map. Next, use a finger on your other hand to locate the number "9" across the top or bottom margin. Now, move both fingers in from the margins toward the map. Where they meet is the general location of the feature. Street names may still be hard to find on a cluttered map, but you have narrowed the search to a specific area.

⇒ Special Traffic Regulations/Traffic Control Devices: This section contains some of the traffic regulations and/or signs (control devices) used within the state that may be different from other states within the region.

DID YOU KNOW?

It is the motorist's responsibility to know the regulations and meanings of all control devices within the region in which he/she is driving. *Ignorance is not an acceptable excuse under the law*.

MAP COLORS

Colors on a road map provide **contrast** to map features, making them easier to identify. Map symbols are usually printed in different colors with each color identifying a class of features. However, colors may vary from one map to another. When used differently, mapmakers indicate these colors and their uses in the marginal information.

Described below are the basic colors used on most road maps and the features they represent. Occasionally, mapmakers may use other colors to indicate special information.

- Black: Indicates the majority of man-made features: *buildings or roads*.
- Blue: Identifies water features: *lakes, swamps, or rivers*.
- Brown: Identifies elevation and relief features: *mountain ranges*.
- Green: Identifies vegetation: *woods, grassland, brush, orchards, or vineyards*.
- Red: Classifies man-made features: *populated areas, main roads, special features, or boundaries on older maps*.

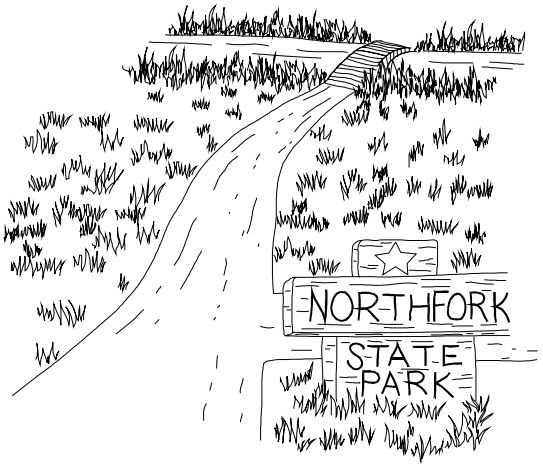
ORIENTING A MAP

Finding your way requires the ability to read and interpret a map, compare it to the features on the ground, and move to the desired location. One method of comparing your map to the ground is to orient it so that the map symbols fit the location of the features as they appear on the ground. A properly oriented map can also indicate direction; that is, after you have it correctly oriented to the ground, the top of it will usually point toward the north.

The following situation shows you how to orient a map without using a compass.

* * *

While participating in a bike rally, Barry traveled off the main road and became lost. He knew for certain he was lost when he came upon the main entrance to *North Fork State Park* on his right. Across from this entrance was a small bridge which crossed the *North Fork River*. Since Barry had a route map for this bike rally, he took the following steps to orient it.



- First, Barry determined his location using at least two known points. He chose to use the man-made features of the bridge and the park entrance and the natural feature of the river.

- Next, he located these same features on his map. With the map in a horizontal position, he rotated it until the symbol for the river was pointed in the same direction as (or aligned with) the river in front of him.

- Barry then checked to ensure that the park entrance was correctly aligned with its actual location. Since from his location the park entrance was located on the right side of the road, he checked to see if the map symbol for the park entrance was also on the right side of the road.

With his map properly oriented, he realized what direction he had to take to rejoin the bike rally.

* * *

In many cases, orienting a map may mean turning it upside down or holding it with one of its edges pointing toward you. Holding a map like this may make it harder for you to read street names or other symbols, but it properly aligns the features on the ground with those on the map. Then, once you know where you are (by using the two or more known points discussed in the above story), keep the map oriented until you are at your destination or in an area familiar to you.

The next time you are on a trip to a place where you have never been before, try this method. *It works!* You will be able to navigate your way to your destination much more easily.

CARE OF MAPS

Since you may have to keep a map for a long time, exercise a lot of care when using it. Three important considerations in the care of maps are:

- Properly refold it after each use.

- Use a pencil if it becomes necessary to mark on it so that you can easily erase those marks.

- Avoid spilling liquids on it.

GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a high-tech worldwide radio-navigation system formed from a network of 24 satellites and their ground stations. GPS provides more precise and efficient methods of surveying and mapmaking. Today, GPS makes it possible to accomplish the same work in a fraction of the time. Mapping is the science of using GPS to pinpoint locations and then create maps of any location in the world, including both natural and man-made features.

CONCLUSION

Maps permit you to see an area of the earth’s surface with the key features of that area properly positioned. They can take the guesswork out of traveling to new locations preventing wasted time and effort. Therefore, make the most of your trips — know how to read and understand your maps beforehand. Even the best maps are useless if you do not know how to properly use them.

* * *

LESSON 2: INTRODUCTION TO TOPOGRAPHICAL MAPS

PURPOSE

This lesson presents an overview of topographic maps. It describes their characteristics and examines the marginal information, symbols, and colors used on them. The remainder of this chapter will focus on the use of topographic maps.

bench marks
declination
grid
grid north
grid zone
magnetic north
nautical miles
orienteering
statute miles
true north

INTRODUCTION

Compared to road maps, topographic maps show more detail of an area's natural features. Because of its detail, especially of terrain features, elevation, and relief, the military prefers this type of map.

After you have mastered the basics of map reading in this chapter, you will most likely have the opportunity to demonstrate your knowledge of these skills during outdoor practical exercises. Whether you are practicing basic land navigation techniques, participating in **orienteering**, or performing land navigation at summer camp, knowing how to use topographic maps can help you in the following ways:

Finding your way if you become separated from a group.

- Successfully, and safely, navigating a group, especially during cross-country movements.
- Determining distances from one location to another.
- Pinpointing locations in a given area.
- Determining the type of terrain in which you or your unit must operate.
- Planning trips or operations.

MARGINAL INFORMATION

The marginal information for topographic maps varies significantly from that of road maps. One major difference is that the marginal information on topographic maps is more standardized than that on other maps. However, all topographic maps are not the same. Consequently, you must examine this information carefully before using each map. This lesson identifies ten items of marginal information that you will need to know when using a topographic map in the remainder of this unit. We will discuss more of these items in subsequent lessons in this chapter.

The topographic map shown on the next two pages (Illustration 2.2.1) is only an extract of how one actually appears; there are three major differences. First, the mapped area and bar scales are drawn to scale, but the extract represents only a small portion of the actual map. Second, we have provided call-outs to help you locate the ten items of marginal information that are described following the map, but we intentionally excluded some of the marginal information. Finally, this map indicates the position of the legend (call-out #10), but Illustration 2.2.2 presents it in more detail.

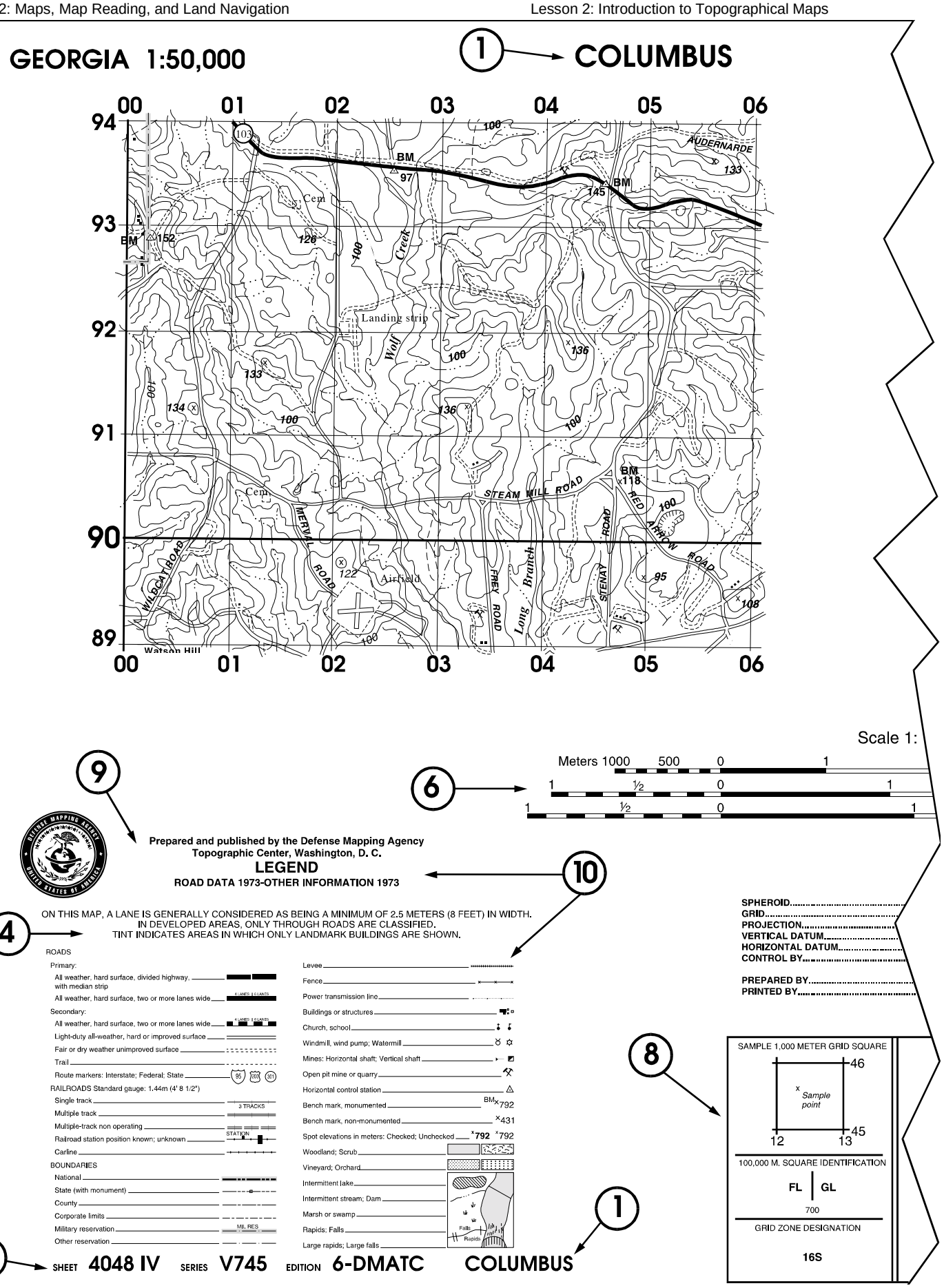
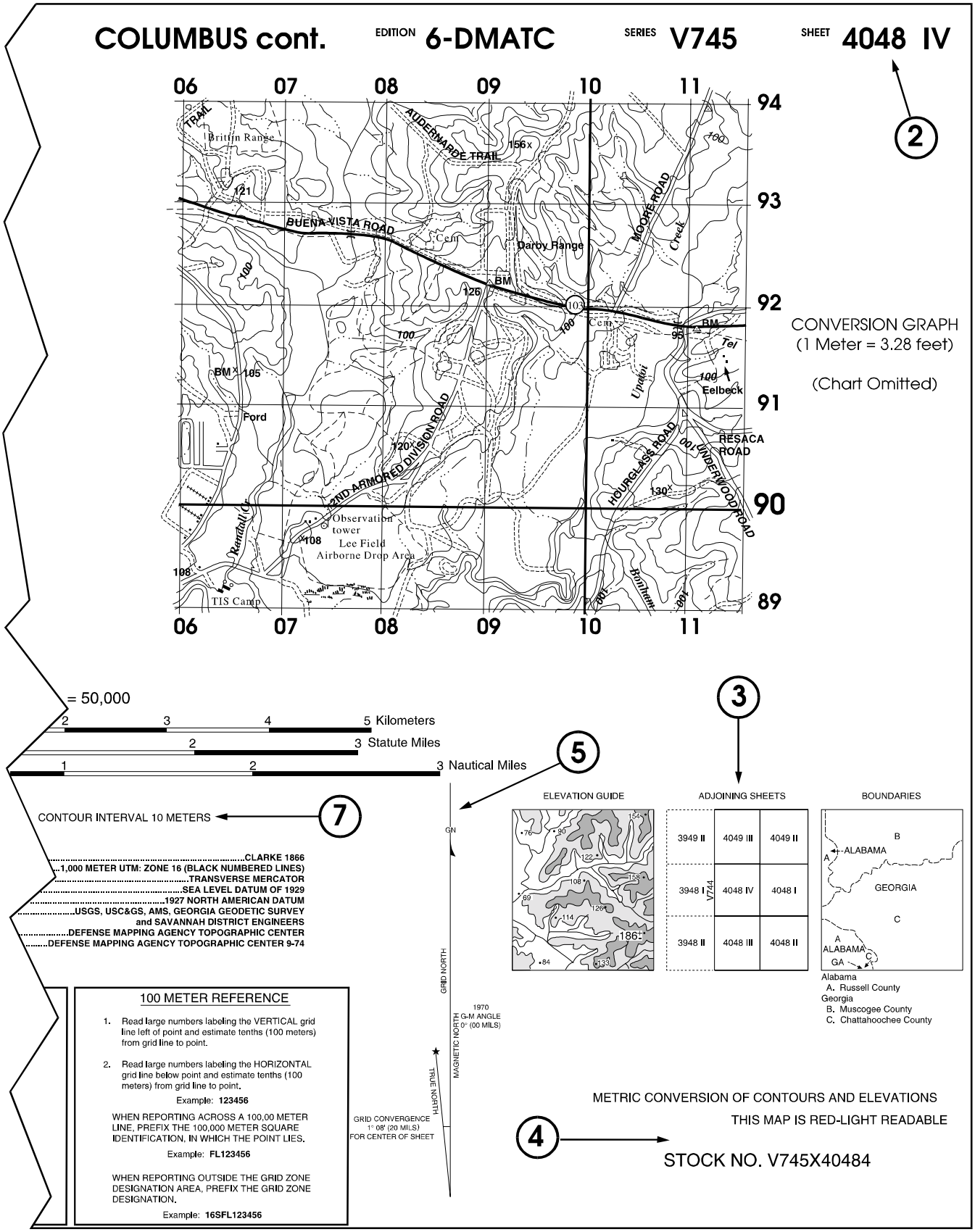

GEORGIA 1:50,000
1
COLUMBUS
00 01 02 03 04 05 06
94 93 92 91 90 89
BM
Cem
Creek
Landing strip
Wolf
STEAM MILL ROAD
MERVIL ROAD
WILDCAT ROAD
FREY ROAD
Long Branch
STENAT ROAD
RED ARROW ROAD
AUDERNARDE
Airfield
Watson Hill
Scale 1:
Meters 1000 500 0 1
9
6
Prepared and published by the Defense Mapping Agency
Topographic Center, Washington, D. C.
LEGEND
ROAD DATA 1973-OTHER INFORMATION 1973
10
4
ON THIS MAP, A LANE IS GENERALLY CONSIDERED AS BEING A MINIMUM OF 2.5 METERS (8 FEET) IN WIDTH.
IN DEVELOPED AREAS, ONLY THROUGH ROADS ARE CLASSIFIED.
TINT INDICATES AREAS IN WHICH ONLY LANDMARK BUILDINGS ARE SHOWN.
ROADS
Primary:
All weather, hard surface, divided highway, with median strip
All weather, hard surface, two or more lanes wide
Secondary:
All weather, hard surface, two or more lanes wide
Light-duty all-weather, hard or improved surface
Fair or dry weather unimproved surface
Trail
Route markers: Interstate; Federal; State
RAILROADS Standard gauge: 1.44m (4' 8 1/2")
Single track
Multiple track
Multiple-track non operating
Railroad station position known; unknown
Carline
BOUNDARIES
National
State (with monument)
County
Corporate limits
Military reservation
Other reservation
Levee
Fence
Power transmission line
Buildings or structures
Church, school
Windmill, wind pump; Watermill
Mines: Horizontal shaft; Vertical shaft
Open pit mine or quarry
Horizontal control station
Bench mark, monumented
Bench mark, non-monumented
Spot elevations in meters: Checked; Unchecked
Woodland; Scrub
Vineyard; Orchard
Intermittent lake
Intermittent stream; Dam
Marsh or swamp
Rapids; Falls
Large rapids; Large falls
SPHEROID
GRID
PROJECTION
VERTICAL DATUM
HORIZONTAL DATUM
CONTROL BY
PREPARED BY
PRINTED BY
8
SAMPLE 1,000 METER GRID SQUARE
46
Sample point
45
12 13
100,000 M. SQUARE IDENTIFICATION
FL GL
700
GRID ZONE DESIGNATION
16S
1
2
SHEET 4048 IV SERIES V745 EDITION 6-DMATC COLUMBUS

Illustration 2.2.1



1. Sheet Name. You can locate the sheet name at the center of the top margin. As with road maps, mapmakers generally title a map after its prominent cultural or geographic feature.

2. Sheet Number. You can find the sheet number located in either the upper right or the lower left corners. Use it as a reference number for the map sheet.

3. Adjoining Map Sheets Diagram. Locate the adjoining (or adjacent) map sheets diagram in the right corner of the lower margin. This diagram contains nine squares; the center square is the map sheet at which you are looking. The remaining squares show the sheet numbers for those maps at the same scale that surround the area covered by the center square.

4. Special Notes. Special notes are statements of general information that relate to the mapped area; for example: the map is red-light readable (located in the lower right corner) or a lane is generally considered as being a minimum of 2.5 meters (located in the lower left corner).

5. Declination Diagram. Another item of information located in the lower right margin is the **declination** diagram. All you need to know at this time is that it indicates the direction and relationship of **true**, **magnetic**, and **grid north**. You will receive instruction on how to use this diagram in LET 2.

6. Scales. Locate the graphic (bar) scales in the center of the lower margin of the map. Compare the differences between these scales and those found on road maps.

⇒ We express a map scale as a representative fraction, which gives the ratio of map distance to ground distance. For example, the scale note 1:50,000 indicates that one unit of measure on the map equals 50,000 units of the same measure on the ground.

⇒ Most topographic maps have more than one scale, each using a different unit of measurement. The most common units of measurement are miles (**statute** and **nautical**), meters/kilometers, and yards.

⇒ Mapmakers divide each scale into two parts: an extension scale and a primary scale. Use the primary scale, located to the right of the zero, to measure full units of measurement. Use the extension scale, located to the left of the zero, to measure tenths of a unit. Read the extension scale right to left from the zero and the primary scale left to right from the zero. (See Illustration 1.)

7. Contour Interval Note. The contour interval note also appears in the center of the lower margin. It represents the vertical distance between contour lines on the map.

8. Grid Reference Box. Located at the bottom center of the lower margin, the **grid** reference box contains information for identifying the **grid zone** and the 100,000 meter square representing the area. It also provides instructions for giving grid references on the map. The next two chapters present information on grid referencing systems and the usefulness of the grid reference box.

9. Unit Imprint. You can find the unit imprint below the left corner of the mapped area. It identifies the agency that prepared and printed the map.

10. Legend. The legend appears below the unit imprint. It states the effective date of the road and other data and illustrates the symbols used on the map. Shown on the next page is an example of a legend.

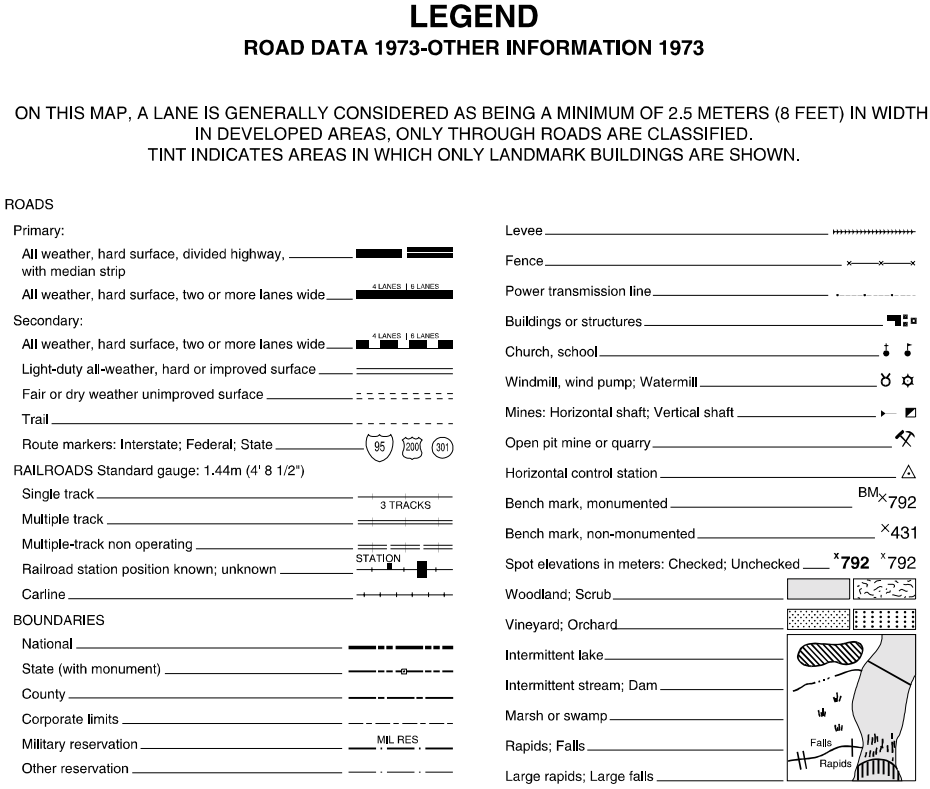


Illustration 2.2.2

MAP SYMBOLS

As in the previous lesson on road maps, topographic maps use symbols to represent the position and shape of features as viewed from above. The legend explains the meanings for the symbols used on a topographic map.

Map symbols on topographic maps are generally in more detail than on other maps. For example, these maps include unimproved roads and trails, different gauges of railroad tracks, power lines, mines or quarries, **bench marks**, and spot elevations. However, the symbols are not always the same on every map. Always refer to the legend to avoid errors when reading a map.

MAP COLORS

The five colors described in the previous lesson (black, blue, brown, green, and red) and the features they represent are also used on topographic maps. In addition, topographic maps use two colors that are usually not found on other maps. These two colors are:

- White: Identifies an area void of vegetation.

- Reddish-brown: Identifies man-made and relief features and elevation (for example, contour lines on red-light readable maps). (**Note:** Brown also identifies relief features and may indicate elevation, or contour lines, on older maps.)

If other colors appear on a topographic map, the marginal information must contain an explanation of their use.

CONCLUSION

The topographic map is the one most commonly preferred by the military because of its detail in portraying terrain features, landforms, the horizontal positions of these features, and elevation/relief. Road maps and topographic maps differ in their marginal information, layout, and scales. However, your ability to read road maps will help you to read topographic maps as well.

* * *

LESSON 3: THE GRID REFERENCE SYSTEM AND SIX-DIGIT GRID COORDINATE

PURPOSE

This lesson introduces you to the universal transverse mercator grid system and the military grid reference system. Once you are familiar with these systems and how mapmakers divide the globe into north-south and east-west rings, you will better understand how to locate and identify points anywhere in the world. From this very broad perspective, this lesson will then show you how to locate a point on a map to within 100 meters using a six-digit **grid coordinate**.

coordinate scale
grid coordinate
grid lines
grid squares
increments
intersects
latitude
longitude
meridians
prime meridian
superimposed
Universal Mercator System

INTRODUCTION

To keep from getting lost, you must know how to find your location. Street addresses may not always be available to you. Learning to use the grid referencing system in conjunction with maps will help you to quickly and accurately pinpoint your location.

LINES OF LATITUDE AND LONGITUDE

By drawing a set of east-west rings around the globe (parallel to the equator), and a set of north-south rings crossing the equator at right angles and converging at the poles, mapmakers can form a network of reference lines from which you can locate any point on the earth's surface — see Illustration 2.3.1.

We refer to the distance of a point north or south of the equator as its **latitude** and the rings around the earth parallel to the equator as parallels of latitude, or simply parallels. *Lines of latitude run east-west, but we measure north-south distances between them*. Starting with zero degrees at the equator, mapmakers number parallels to 90 degrees both north and south.

We refer to a second set of rings around the globe that are at right angles to the lines of latitude and that pass through the poles as **meridians** of **longitude**, or simply meridians. One meridian is the **prime meridian**, which runs through Greenwich, England. The distance east or west of the prime meridian to a point is known as its longitude. *Lines of longitude run north-south, but we measure east-west distances between them*. Starting with zero degrees at the prime meridian, mapmakers number meridians to 180 degrees both east and west.

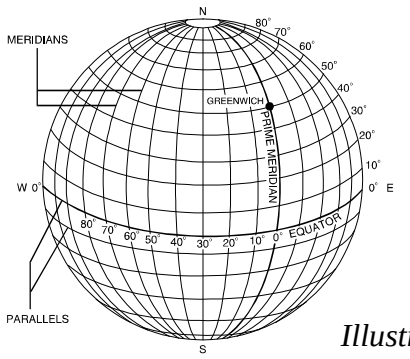


Illustration 2.3.1

UTM GRID SYSTEM

The U.S. military **superimposed** its grid reference system on the Universal Transverse Mercator Grid System, or UTM grid system. To better understand the military's grid reference system, you should have a basic knowledge of the UTM grid system.

The UTM grid system divides the surface of the earth into 60 north-south grid zones (each six degrees wide) like the one in Illustration 2.3.2. Mapmakers number these zones from west to east, 1 through 60, starting at the 180 degree meridian. The grid zone in Illustration 2.3.2 represents grid zone number 3.

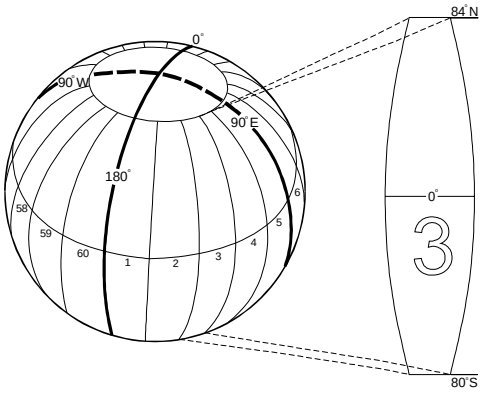


Illustration 2.3.2

Illustration 2.3.3 is this same grid zone, but now further divided into 20 north-south segments. We give each grid segment a letter for identification. Mapmakers use the letters "C" through "X" (omitting the letters "I" and "O") to identify these 20 grid segments. They do not use "I" and "O" because those letters can easily be mistaken for the numbers "1" and "0," respectively. Nineteen of these grid segments are eight degrees high and the one row at the extreme north is 12 degrees high. This combination of zone number and row letter constitutes the grid zone designation.

With this designator, we are now able to identify specific grids. For example, if we wanted to locate the first segment north of the equator, its grid zone designation would be 3N.

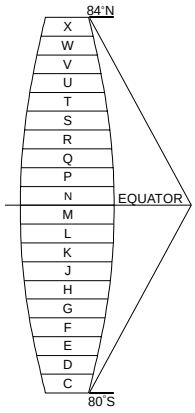


Illustration 2.3.3

However, if you were to cut out 60 shapes identical to those in Illustrations 2.3.2 or 2.3.3, your globe would not be complete at either end. Each of these 60 grid zones lay between the 84 degrees north and the 80 degrees south lines of latitude. The polar regions would be missing. Therefore, to complete your globe, extend these grid lines to 90 degrees in both directions: 90 degrees north latitude is the North Pole and 90 degrees south latitude is the South Pole. Mapmakers use the remaining four letters, "A," "B," "Y," and "Z" to identify the polar regions as shown in Illustration 2.3.4.

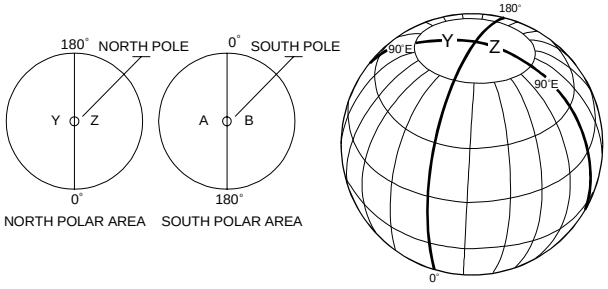


Illustration 2.3.4

MILITARY GRID REFERENCE SYSTEM

Superimposed on each grid zone segment are 100,000 meter squares. We identify each 100,000 meter square by two identification letters (see Illustration 2.3.5). The first letter is the column designation and the second letter is the row designation.

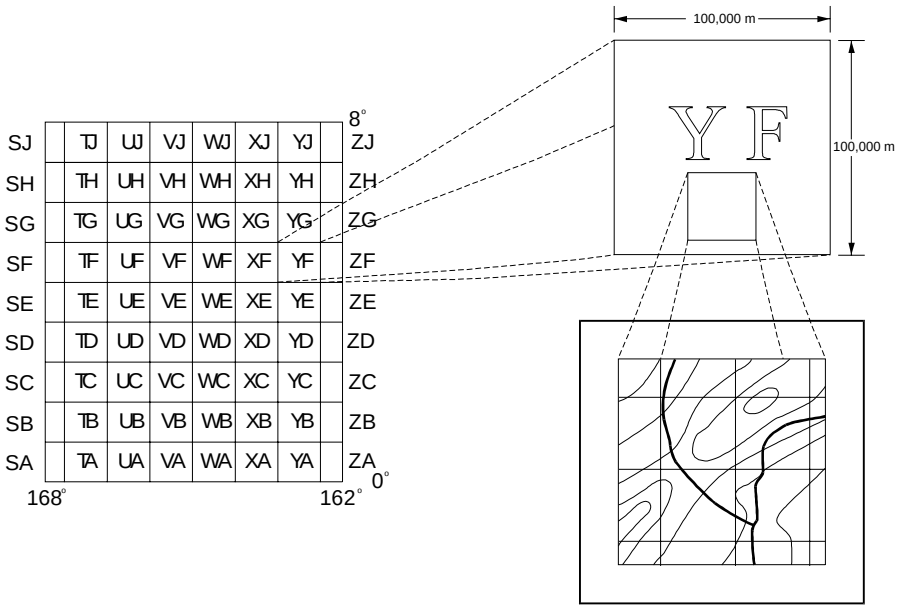


Illustration 2.3.5

We then further divide each 100,000 meter square by parallel lines (or **grid lines**) that are 1,000 meters or 10,000 meters apart (depending on the scale of the map). These parallel lines come together at right angles to form 1,000 meter or 10,000 meter squares (called **grid squares**) — see Illustration 2.3.6. These grid lines and grid squares are the lines that you see on a standard military topographic map. Mapmakers number grid lines along the outside edge of each topographic map for easy reference. Using the two 100,000 meter square identification letters in conjunction with these numbers, you can identify each grid square accurately, without any two grid squares having the same grid number (or grid coordinate).

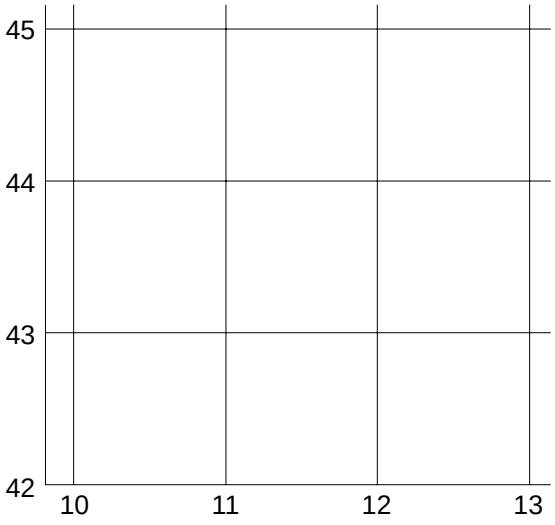


Illustration 2.3.6

LOCATING A POINT USING THE MILITARY GRID REFERENCE SYSTEM

Whenever you read a grid coordinate, you always read right first, then up. This is one of the cardinal rules in map reading. Based on this rule, you can determine locations on a map using grid coordinates. The number of digits in a grid coordinate represents the degree of precision to which you can locate and measure a point on a map — the more digits, the more precise the measurement. For example, a four-digit grid coordinate locates a point to within 1,000 meters, a six-digit grid coordinate to within 100 meters, and an eight-digit grid coordinate to within ten meters.

You write grid coordinates as one continuous alphanumeric symbol without spaces, parentheses, dashes, or decimal points. Further, grid coordinates must always contain an even number of digits, both letters and numbers. In order to determine grid coordinates without using a protractor, the reader simply refers to the grid lines numbered along the margin of any map. The following example shows how to form a four-digit grid coordinate.

Suppose you want to locate *Spot Elevation 450* in Illustration 2.3.7 to the nearest 1,000 meters.

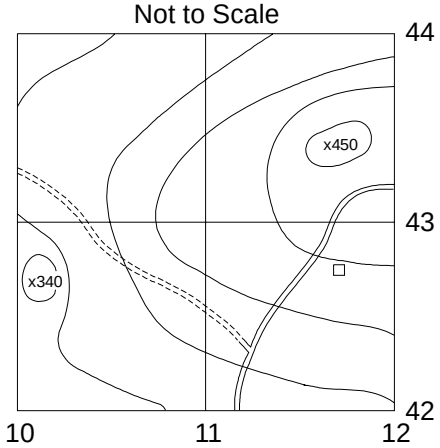


Illustration 2.3.7

1. Identify the 100,000 meter square identification letters for the map you are using. You can find this identification in the Grid Reference Box located at the bottom center of the lower margin of a topographic map. For this example, we will continue to use the "YF" identifier from Illustration 2.3.5.

Note: The next two steps would normally be to break down the 100,000 meter square into 10 equal 10,000 meter grid squares, then to further break down one of those into 10 equal 1,000 meter grid squares. However, we will omit these steps since our example already has 1,000 meter grid squares.

1. Identify the 1,000 meter grid square in which the spot elevation is located. To do this, remember the first cardinal rule of map reading: read right, then up. When reading a map right and up, each north-south grid line increases in value from west to east, and each east-west grid line increases in value from south to north.

2. Read right. We see that the last north-south grid line before reaching the grid square containing *Spot Elevation 450* is 11.

3. Read up. Note that the last east-west grid line before reaching the grid square containing *Spot Elevation 450* is 43.

4. Combine these steps by writing the 100,000 meter square identifier (YF) and the coordinates of the 1,000 meter grid square (11 and 43) as one continuous symbol. Thus, you would write this grid coordinate as YF1143. You have now correctly located a point on the map (*Spot Elevation 450*) to the nearest 1,000 meters and written a four-digit coordinate.

LOCATING A POINT USING SIX-DIGIT GRID COORDINATES

To locate a point to within 100 meters, follow the procedures in the previous lesson, and add one more step. In this step, you must divide the 1,000 meter grid square into tenths, or 100 meter **increments**. Illustration 2.3.8 shows what a 1,000 meter grid square would look like if you divided it into 100 meter segments.

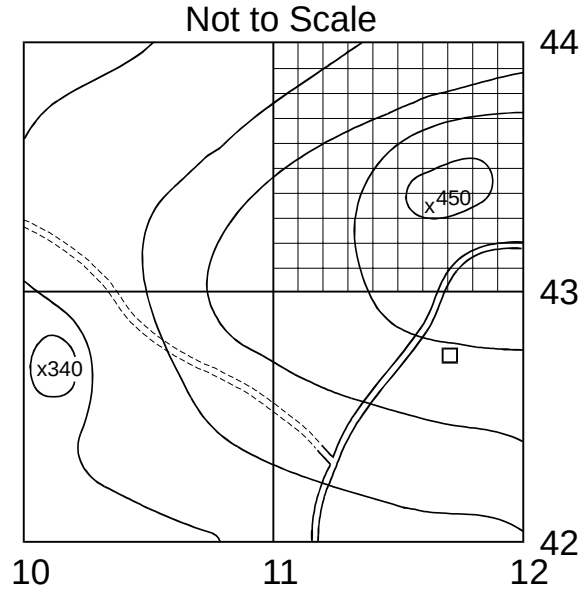


Illustration 2.3.8

Suppose we now want to again locate *Spot Elevation 450*, but this time to within 100 meters. First, read right. *Spot Elevation 450* is approximately six-tenths into the grid square. The right reading then is the value of the last north-south grid line before reaching this grid square, or 11, plus a 6 for the six-tenths. We would read this value as 116.

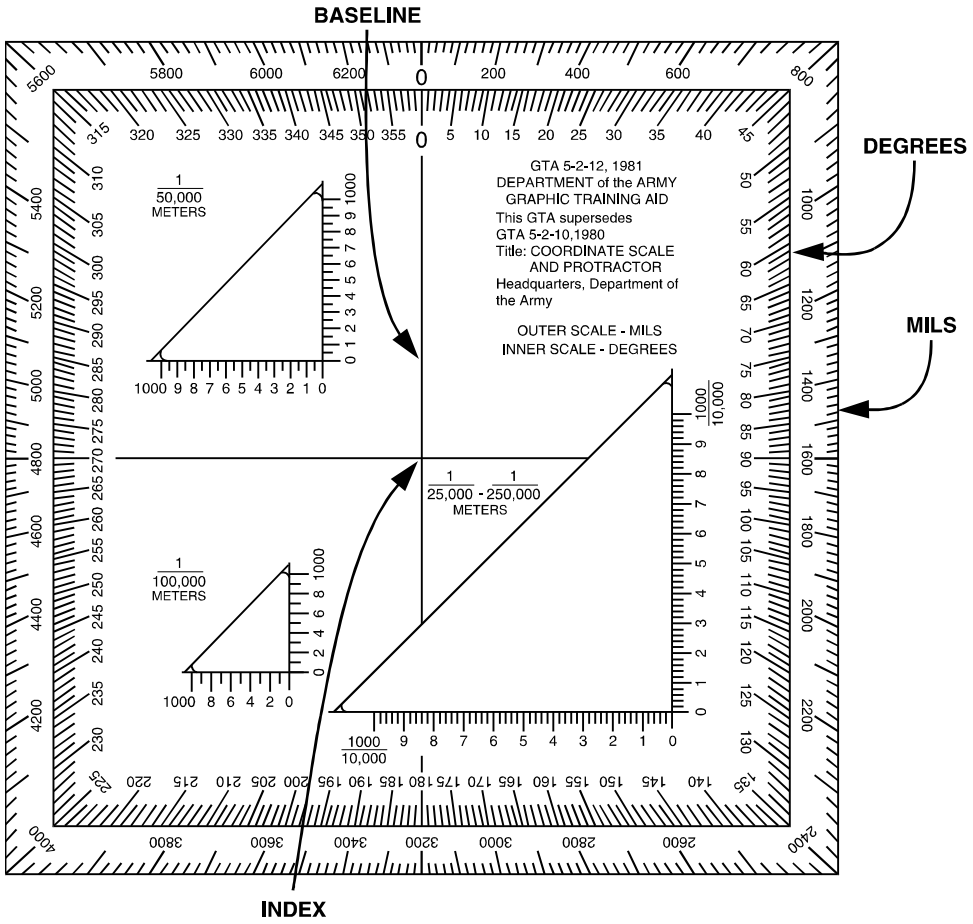
By reading up, you can see that *Spot Elevation 450* is approximately four-tenths of the way up into the grid square. Therefore, the up reading is the value of the last east-west grid line before reaching this grid square, or 43, and a 4 for the four-tenths. We would read this value as 434.

Combining both of these numbers and the 100,000 meter square identifier labels the location as YF116434 for *Spot Evaluation 450*. You have now used one method to locate a point to the nearest 100 meters by using a six-digit grid coordinate.

USING A COORDINATE SCALE

Another way to locate a point to within 100 meters is to make use of a coordinate scale. The following is the correct way to use a coordinate scale. To explain this procedure, we will once again find the six-digit grid coordinate for *Spot Elevation 450*.

The coordinate scale used by the Army is the one shown on the next page. Note that in the center, it has three different scales: 1:100,000 meters, 1:50,000 meters, and 1:25,000 meters (or 1:250,000 meters).



First, check to ensure that you are using the correct scale. (**Note:** If you obtained a coordinate scale from the JROTC instructor staff, use the 1:25,000 scale for Illustrations 2.3.9 and 2.3.10.) Place the horizontal scale parallel to and directly on top of grid line 43 with the "0 mark" at the lower left-hand corner of grid square YF1143 (see Illustration 2.3.9).

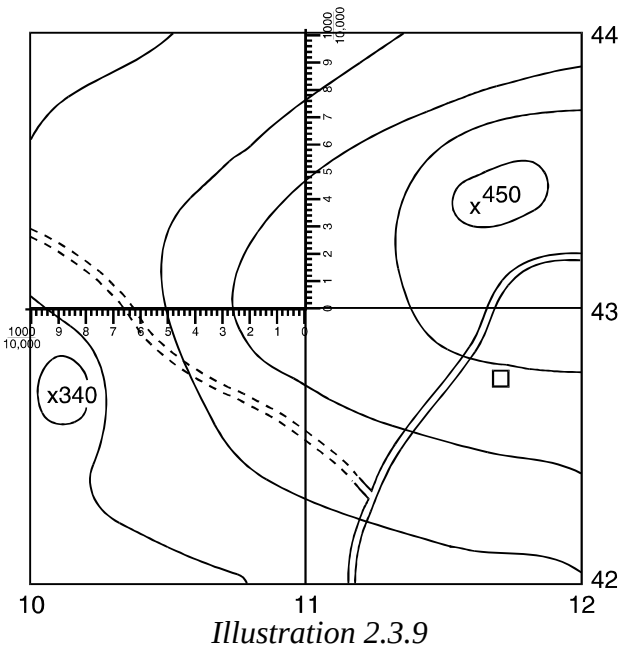


Illustration 2.3.9

Keeping the horizontal scale on top of the 43 grid line, slide the scale to the right into the grid square until the vertical scale **intersects** the center of mass of *Spot Elevation 450* (see Illustration 2.3.10).

Now, reading left from the "0 mark," you can see that *Spot Elevation 450* lies almost directly on the six-tenths indicator. Therefore, we would read this number as 116. (**Note:** When you have to round off numbers using a coordinate scale for a six-digit coordinate, apply the following rule: *round down for numbers that are four or less; round up for numbers that are five and above*.)

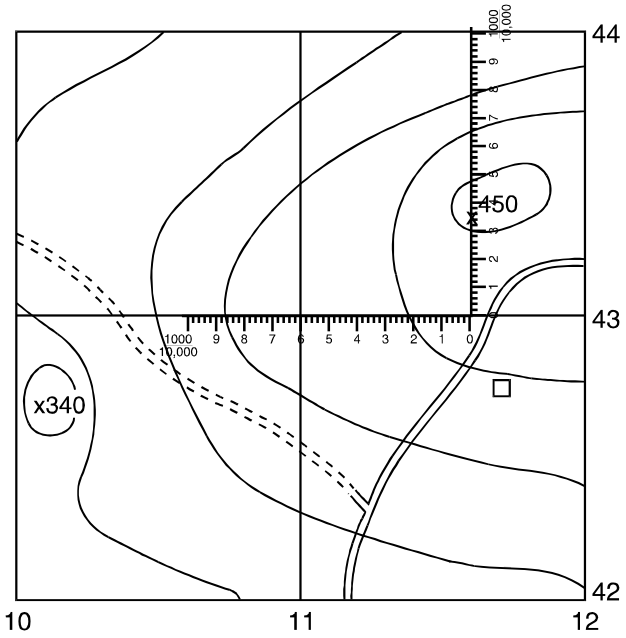


Illustration 2.3.10

Reading up, you can see that *Spot Elevation 450* lies midway between the three and four mark on the coordinate scale. By applying the above rounding-off rule, round up to read this number as 434. Next, combine both sets of numbers and add the 100,000 meter square identifier to give you the location of YF116434. You have now correctly located a point to the nearest 100 meters by using a coordinate scale.

GRID REFERENCE BOX

The grid reference box found on topographic map sheets contains step-by-step instructions for using the grid and military grid reference systems. Mapmakers divide the grid reference box into two parts (see Illustration 2.2.1).

The left portion identifies the grid zone designation and the 100,000 meter square identifier. If the map sheet falls in more than one 100,000 meter square, the number of the grid line that separates these squares and the 100,000 meter square identifications are given. The right portion briefly explains how to find and write a six-digit coordinate.

CONCLUSION

Being successful at map reading requires a thorough understanding of many basic concepts. This chapter has presented several precise systems of finding locations on maps. Your ability to use these systems and to locate four-and six-digit grid coordinates can increase your confidence in identifying your location.

* * *

LESSON 4: CONTOURS AND LANDFORMS

PURPOSE

The next step to improving your map reading skills is to understand elevation and relief. This understanding includes your ability to recognize the different types of land formations.

This lesson introduces these two basic elements of map reading. First, it explains the concepts of contour lines and intervals. Mapmakers use them to show elevation and relief on a map as they would appear on the ground. Second, it explains and illustrates the 10 types of natural and man-made terrain features along with their corresponding contour lines.

concave
concentric
convex
cut
depression
draw
fill
hachures
mean sea level
ridge
ridgeline
saddle
sinkhole
spur

INTRODUCTION

Earlier in this chapter, we mentioned that orienting a map requires the identification of at least two known points. Recall the story of Barry who became lost while on a bike rally. What would he have done if the bridge, river, and park entrance were not there? He would have had to rely on his knowledge of elevation, relief, and terrain features to orient his map and determine his location. Competently using your map reading skills is extremely important in accomplishing your mission, regardless if you are on a land navigation exercise, a trip, a bike rally, etc.

METHODS OF SHOWING RELIEF

Knowing what the terrain looks like along your route before you start a trip may save you time and trouble in reaching your destination. Elevation is the height, or vertical distance, of a point on the earth's surface above or below **mean sea level**. Maps show elevation in feet, meters, or yards. Relief is the shape of landforms on the earth's surface.

Mapmakers use five methods to show elevation and relief on a map: layer tinting, form lines, shaded relief, **hachures**, and contour lines. We will define all of these methods, but we will use only the contour lines in the remainder of your *Map Reading* instruction.

- Layer tinting shows relief by color. Mapmakers use a different color for each band of elevation. Each band represents a separate elevation range. Each range is defined in the legend. However, this method does not allow you to determine the exact elevation of a specific point — only its range.

- Form lines do not have a standard elevation and they give only a general idea of relief. Mapmakers show form lines as dashed lines on a map without elevation numbers.

- Shaded relief shows relief by a shadow effect on one side of terrain features. Mapmakers achieve the shadow effect by using tones and colors to darken one side of features (such as hills or ridges). The darker the shading, the steeper the slope. This

method is sometimes used with contour lines to emphasize those features.

- Hachures show relief using short broken lines. Mapmakers use them to show large, rocky outcrop areas and, on small-scale maps, to show mountain ranges, plateaus, and mountain peaks. As in the above methods, however, they do not represent exact elevations.

- Contour lines show relief and elevation on a standard topographic map. A contour line represents an imaginary line on the ground, above or below sea level. All points on a contour line are at the same elevation. Contour lines never cross one another. Standard colors for contour lines are brown, red, or black. The following are three types of contour lines:

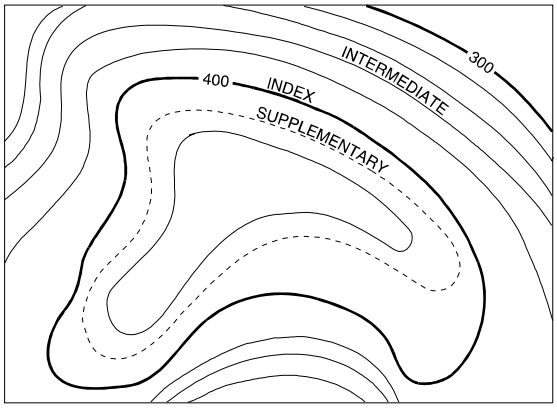


Illustration 2.4.1

1. *Index*. Starting at zero elevation, or mean sea level, every fifth contour line is always an index contour line, regardless of the contour interval. Mapmakers show index contour lines as a heavily drawn line with its elevation given somewhere along it, except where the contour interval is too small to print the elevation.
2. *Intermediate*. The contour lines that fall between the index lines are the intermediate contour lines. These lines are more finely drawn and they do not show the elevation number. On U.S. maps, there will always be four intermediate contour lines between indexed lines.
3. *Supplementary*. These contour lines resemble dashes. They show sudden changes in elevation of at least one-half the contour interval for that map. If the map uses supplementary contour lines, do not count them as regular contour lines.

CONTOUR INTERVALS

Printed below the bar scales in the middle of each map is the contour interval. This interval is the difference in height, or elevation, between one contour line and the one next to it.

You can estimate or determine the elevation of a point on a map by following the steps indicated below.

1. Determine the contour interval and the unit of measurement (feet, meters, or yards) from the marginal information.

2. Find the numbered index contour line nearest your point.

3. Count the number of intermediate contour lines to your point. If you are increasing elevation, add the contour interval to the nearest index contour line. If you are decreasing elevation, subtract the contour interval from the nearest index contour line.

   For example, the point you want to locate is on the second intermediate contour line above the 300 meter index contour line (see Point A on Illustration 2.4.2). Note, the contour interval for this example is 20 meters. Since your point is closer to the 300 meter index contour line, start there and for each one of the intermediate contour lines that you cross or arrive at to reach your point, add 20 meters to the value of the

300-meter index line. Thus, the elevation of Point A is 340 meters. Notice that your elevation has increased.

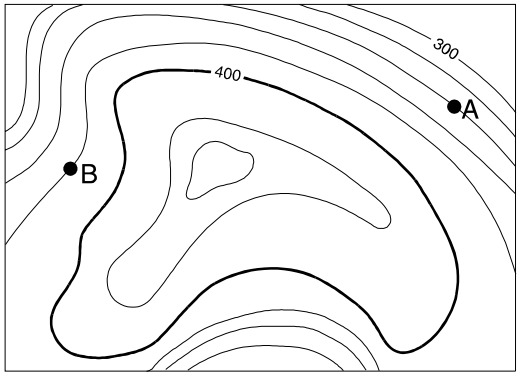


Illustration 2.4.2

However, let's say that your point (Point B) is now located on the intermediate contour line immediately below the 400 meter index contour line. Below means downhill, or at a lower elevation. Therefore, for the one intermediate contour line that you arrive at to reach this point, subtract 20 meters from the value of the 400 meter index line. The elevation of Point B is 380 meters.

To determine the elevation of the top of an unmarked hill, add one-half the contour interval to the elevation of the last (highest) contour line around the hill. In our example, the last contour line before the hilltop is an intermediate contour line at an elevation of 440 meters. Add one-half the contour interval, or 10 meters, to the value of this intermediate contour line. The elevation of the hilltop is 450 meters.

There may be times when you must estimate the elevation between contour lines. For example, for a point half-way between contour lines, estimate the elevation to one-half the contour interval. For points less than one-forth the distance between the lines, use the same elevation as the nearest line. Remember, if the desired point is on a contour line, its elevation is that of the contour line.

To estimate the elevation to the bottom of a **depression**, subtract one-half the contour interval from the value of the lowest contour line before the depression. In Illustration 2.4.3 (with the contour interval still at 20 meters), the lowest contour line before the depression is 240 meters, which is also the elevation at the edge of the depression. Since 10 meters is one-half the contour interval, the bottom of this depression is 230 meters. The tick marks on the contour line forming a depression always point to lower elevations.

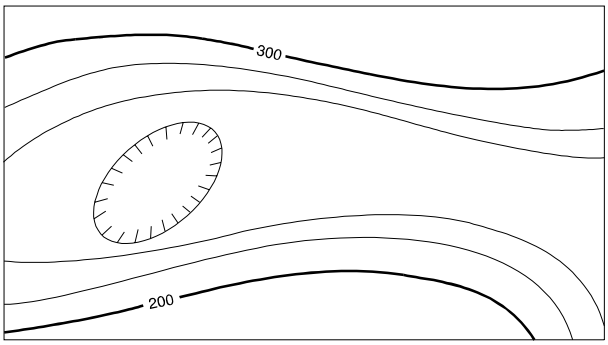


Illustration 2.4.3

In addition to contour lines, mapmakers use bench marks and spot elevations to indicate points of known elevation on a map. Bench marks (abbreviated BM) are the more accurate of the two. Mapmakers show a bench mark with a black "X" (such as BMx214) with the center of its elevation given in feet, meters, or yards above sea level. Mapmakers show spot elevations with a brown "X" to mark road junctions, hilltops, or other prominent terrain features.

LANDFORMS

In addition to the map symbols introduced earlier in this unit, mapmakers use symbols to represent natural land formations of the earth's surface. They position them on a map so that the center of the symbol remains in its true location. These symbols closely resemble the actual features when viewed from above.

No matter where you live, there are hills, valleys, streams, or other landforms in your area. The relief of an area is the illustration of these shapes as depicted on a map. For example, the relief of Denver would be different from that of Salt Lake City.

Most maps depict up to a total of 10 different natural or man-made landforms or terrain features. All terrain features result from landmasses known as mountains or ridgelines. A **ridgeline** is a line of high ground, usually with changes in elevation along its top and low ground on all sides, from which mapmakers classify the 10 terrain features.

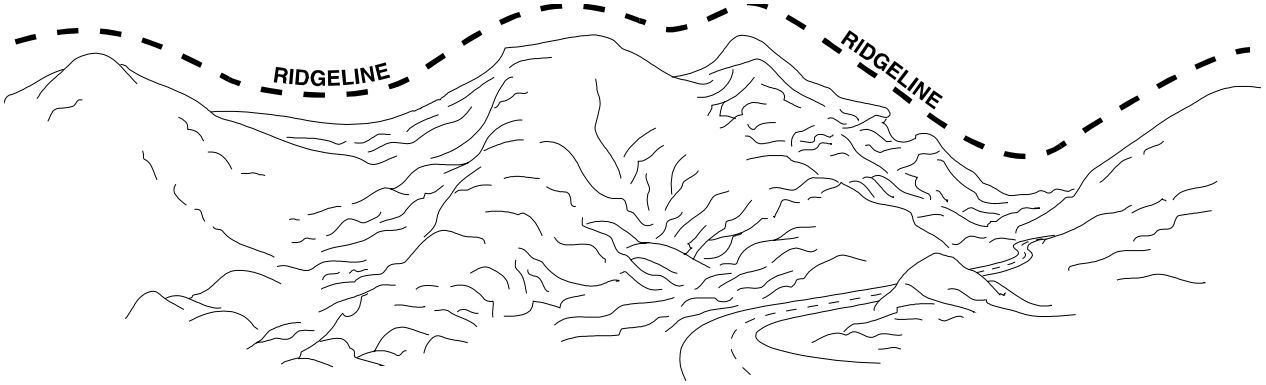


Illustration 2.4.4

TERRAIN FEATURES

We can divide the 10 natural or man-made terrain features into three categories: major features, minor features, and supplementary features. There are five major features, two minor features, and three supplementary features.

The five major terrain features are:

- hill
- **saddle**
- valley
- **ridge**
- depression

Hill

A hill is an area of high ground (see Illustration 2.4.5). When you are located on a hilltop, the ground slopes down in all directions. Maps will show a hill with a regular closed contour line, or a series of **concentric** closed contour lines. The inside of the smallest closed circle is the hilltop. The more contour lines, the higher the hill.

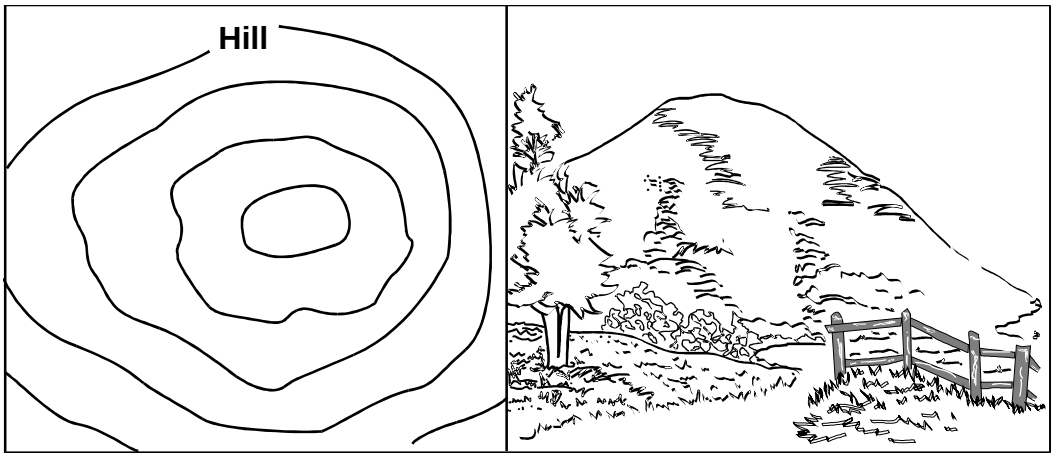


Illustration 2.4.5

Saddle

A saddle is a dip or low point between two areas of higher ground (see Illustration 2.4.6). It is not necessarily the lower ground between two hilltops; it may simply be a dip or break along a level ridge or crest. If you were in a saddle, there would be high ground in two opposite directions and lower ground in the other two directions. Maps will show a saddle with the contour lines forming an hourglass or a figure-eight-shaped feature.

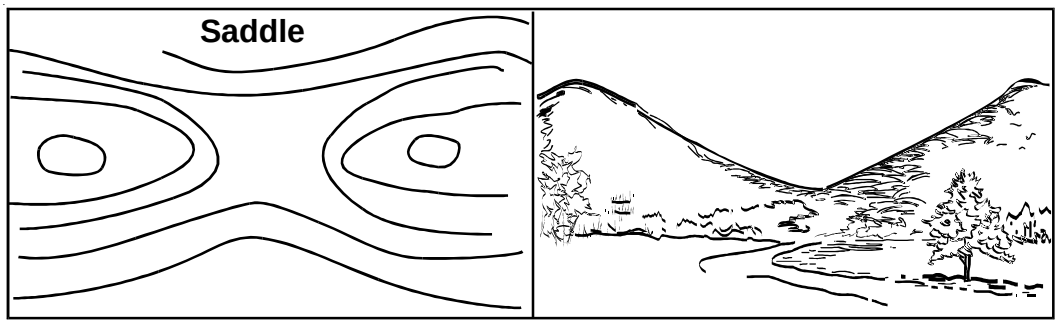


Illustration 2.4.6

Valley

A valley is a stretched-out groove in the land, usually formed by streams or rivers (see Illustration 2.4.7). A valley begins with high ground on three sides, and usually has a course of running water through it, which always flows from higher to lower ground. If you were standing in a valley, there would be high ground in two opposite directions and a gradual slope in the other two directions. Contour lines forming a valley are either “U-shaped” or “V-shaped.” To determine the direction water is flowing, look at the contour lines. The closed end of the “U” or “V” always points upstream or toward the high ground.

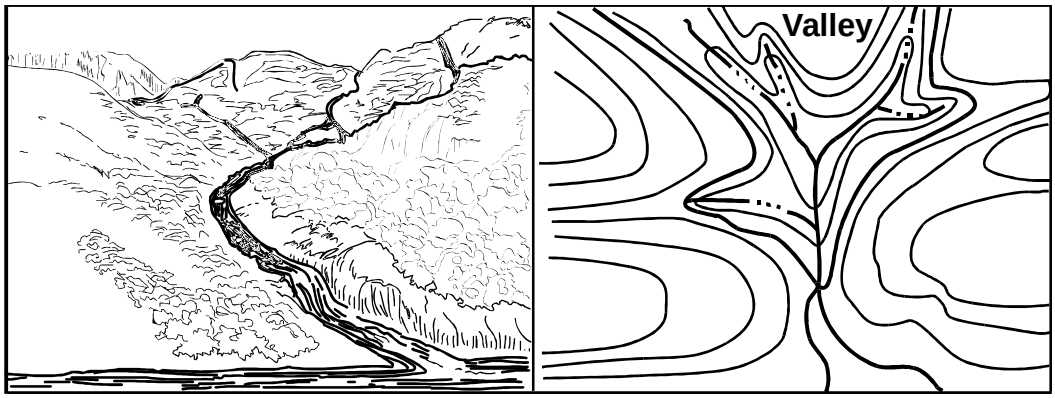


Illustration 2.4.7

Ridge

A ridge is a sloping line of high ground (see Illustration 2.4.8). If you were standing in the center of a ridge, you would normally have low ground in three directions and high ground in one direction.

If you cross a ridge at right angles, you climb steeply to the crest, and then descend steeply to the base. When you move along the path of the ridge, depending on your location, there may be either a barely noticeable slope or a very obvious incline. Contour lines forming a ridge tend to be "U-shaped" or "V-shaped." Notice that the closed end of the contour line points away from high ground.

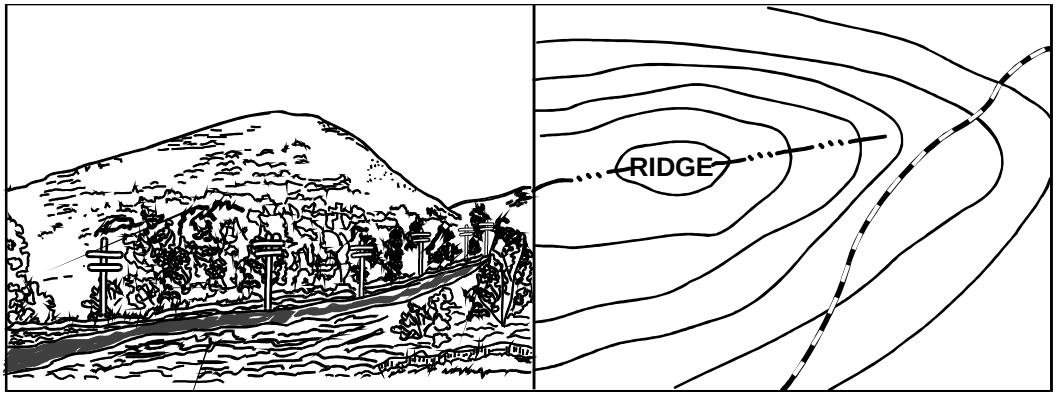


Illustration 2.4.8

Depression

A depression is a low point in the ground, or a **sinkhole**, surrounded by higher ground in all directions (see Illustration 2.4.9). Maps will show depressions by closed contour lines that have tick marks pointing toward the low ground. The closer the contour lines, the deeper the depression.

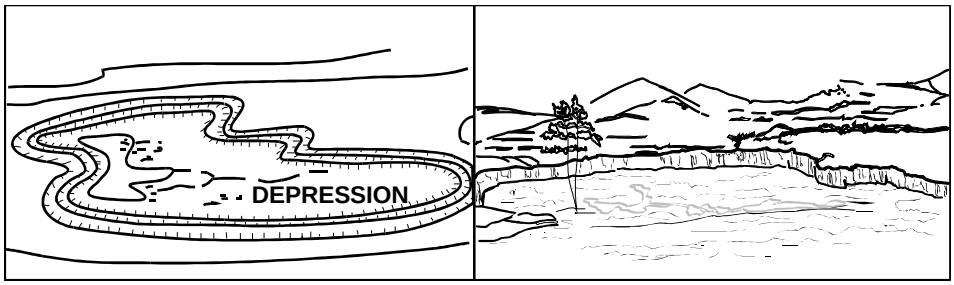


Illustration 2.4.9

The two minor terrain features are **draw** and **spur**.

Draw

A draw is a less developed stream course than a valley (see Illustration 2.4.10). There is no level ground. If you were standing in a draw, the ground would slope up in three directions and down in the other. A draw is sometimes considered to be the initial formation of a valley. Maps will show a draw as a series of successive "U-shaped" or "V-shaped" contour lines that point uphill or upstream.

Spur

A spur is a short, continuous sloping line of high ground, normally jutting out from the side of a ridge (see Illustration 2.4.11). It is often formed by two parallel streams cutting draws down the side of a ridge. The ground will slope down in three directions and up in one. Maps will show a spur as a series of successive "U-shaped" or "V-shaped" contour lines that point in a downhill direction.

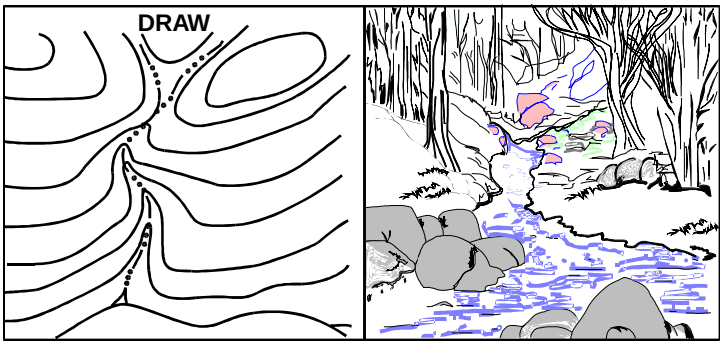


Illustration 2.4.10

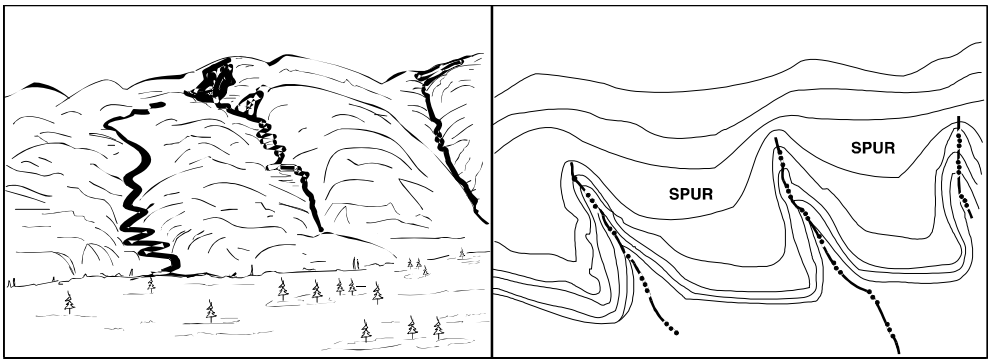


Illustration 2.4.11

In the final category, the three supplementary terrain features are cliff, **cut**, and **fill**.

Cliff

A cliff is a vertical or near vertical slope that is an abrupt change of the land formation (see Illustration 2.4.12). Maps show the contour lines for cliffs as being very close together, and in some cases, touching each other.

Note: Although, as a general rule, a regular contour line is never broken, there are two exceptions when illustrating a cliff or a very steep slope. A contour line may be broken or may converge. Also, a contour line may be broken for the purpose of printing the elevation number.

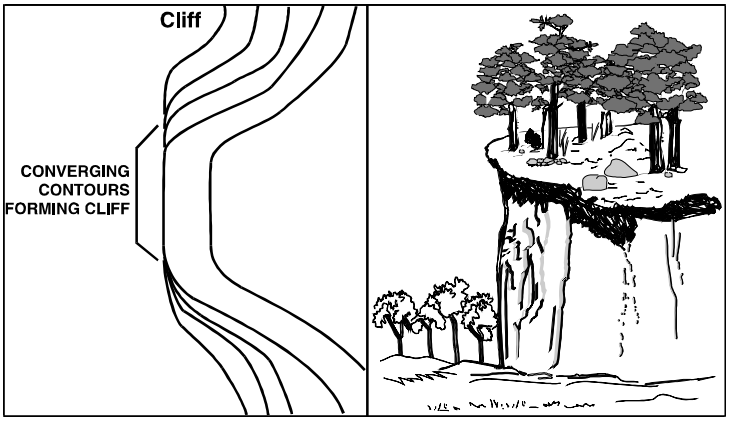


Illustration 2.4.12

Cut and Fill

Cuts and fills are man-made features resulting from the cutting through of high areas and the filling in of low areas to form a level bed for a road or railroad track (see Illustration 2.4.13). Maps will show cuts when they are at least 10 feet high. Mapmakers draw the contour lines along the length of the cut. They also use tick marks to extend from the cut line to the roadbed, if the map scale permits this level of detail.

As with cuts, maps will show fills when they are at least 10 feet high. Mapmakers draw the contour lines along the fill line for the length of the filled area and use tick marks to point toward the lower ground.

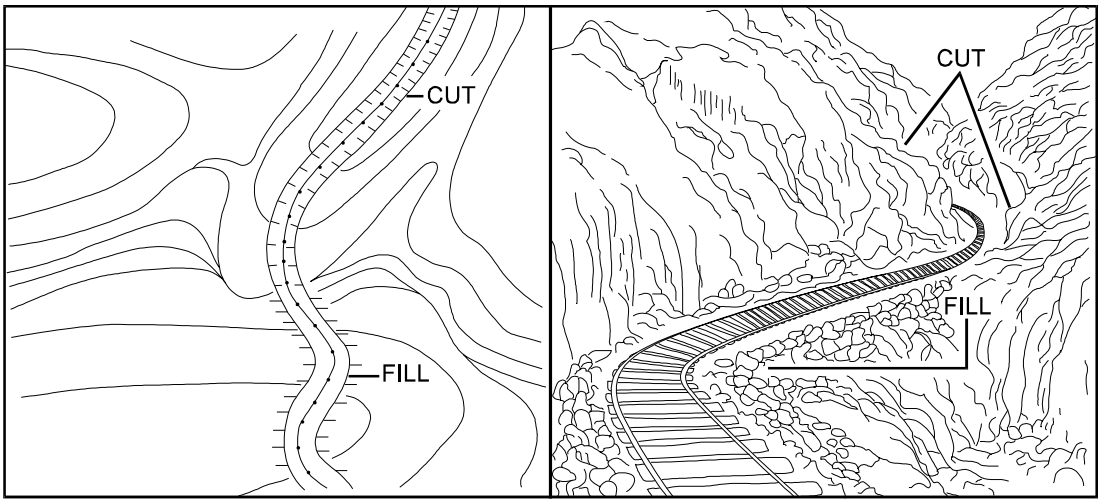


Illustration 2.4.13

Your hand can help you visualize eight of the terrain features mentioned above. (see Illustration 2.4.14). You can demonstrate all but cuts and fills.

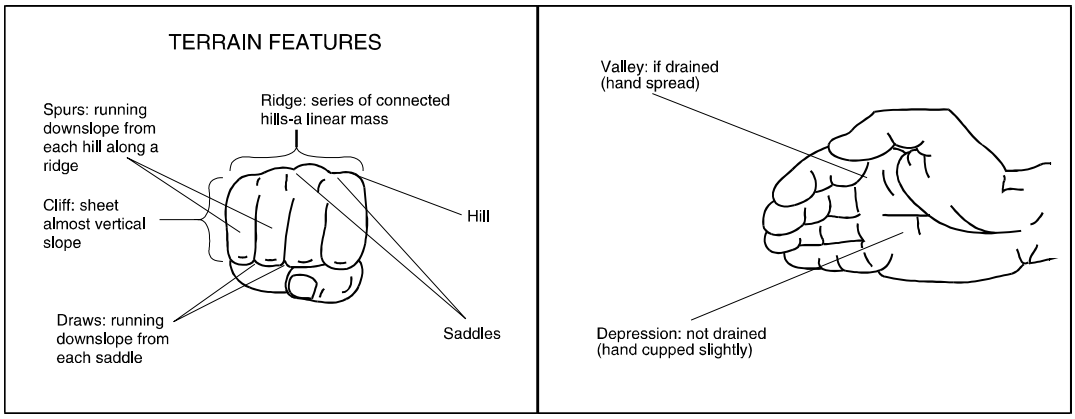


Illustration 2.4.14

TYPES OF SLOPES

The rate of the rise or fall of the ground is known as its slope. You can determine slope by studying the contour lines on a map — the closer the contour lines, the steeper the slope; the farther apart the contour lines, the gentler the slope. The four types of slopes are gentle, steep, **concave**, and **convex**. Illustration 2.4.15 gives an example of each slope.

Maps show the contour lines for concave slopes as being closely spaced at the top of the feature and widely spaced at the bottom. Contour lines for convex slopes are just the opposite.

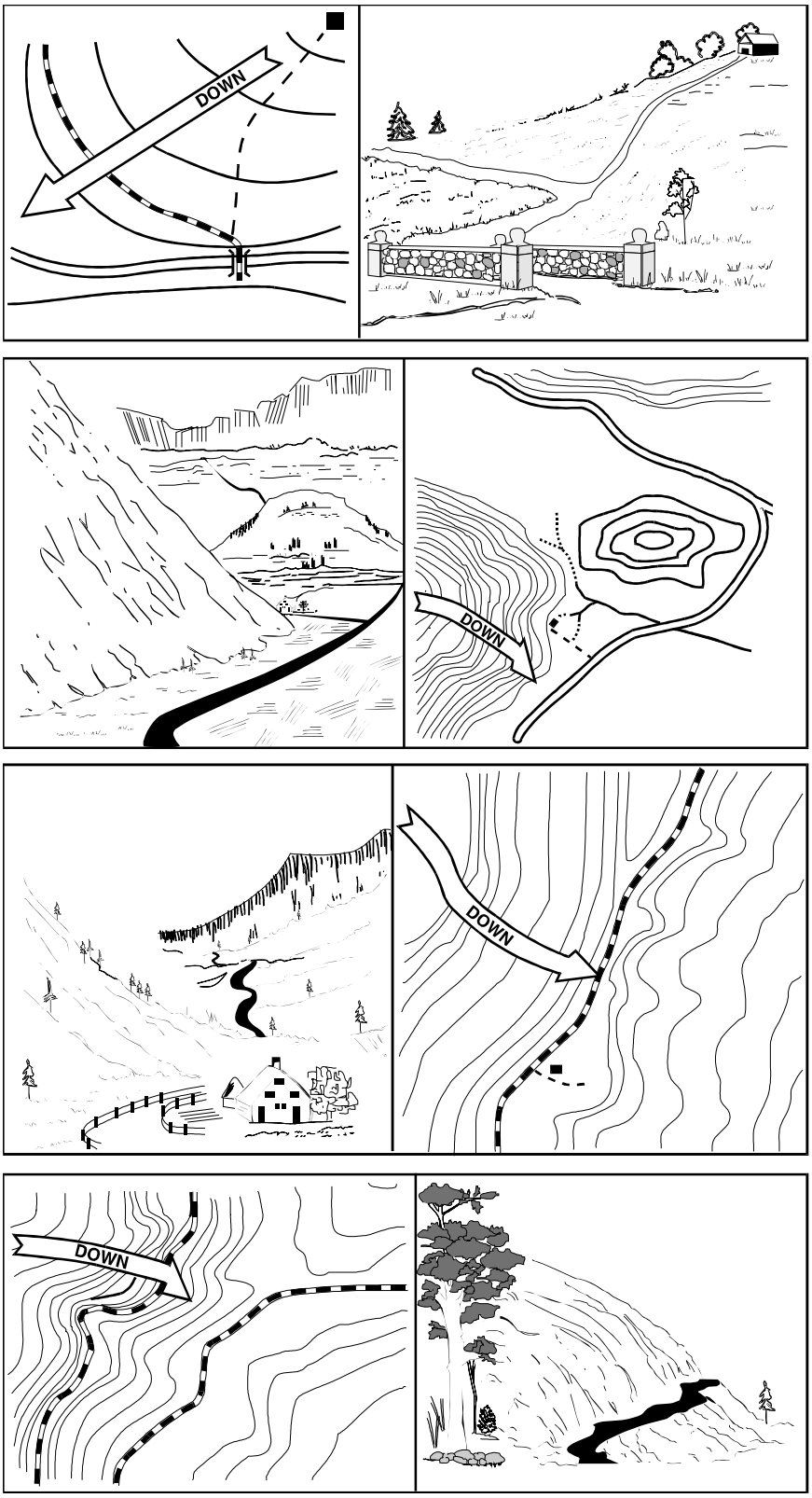


Illustration 2.4.15

CONCLUSION

In this lesson we presented two fundamental concepts of land navigation: understanding elevation and relief and recognizing terrain features.

Practice using these concepts. Study the contours and landforms within your region. When traveling, look for differences in terrain and elevation. Become successful in applying your map-reading skills so that you will always be able to answer the question, "*Where am I*?"

* * *

LESSON 5: DETERMINING DISTANCE

PURPOSE

Navigating from one point to another with the use of a map and compass involves the ability to apply simple map reading skills. In previous lessons, we discussed how to plot locations on a map. In these next lessons, we will show you how to determine distance and direction to those locations, both on the map and on the ground. Then, we will show you how to convert a grid azimuth on a map to a magnetic azimuth on the ground and vice versa. When you have successfully completed the next three lessons, you will know "how to get there."

center of mass
nautical miles
representative fraction
statute miles

INTRODUCTION

In previous lessons, we explained that a map is a scaled graphic drawing of a portion of the earth's surface. The scale of the map allows the user to convert distance on it to distance on the ground or vice versa. The ability to determine distance on a map, as well as on the earth's surface, is an important factor in plotting a distant location and determining how to get there.

There are two methods of determining distance on a map using the scales found in the marginal information.

- Mapmakers express a map scale as a **representative fraction**, which gives the ratio of map distance to ground distance. For example, the scale 1:50,000 indicates that one unit of measure on the map equals 50,000 units of the same measure on the ground. The most common units of measurement are miles, meters, and yards.

- Mapmakers divide the graphic (bar) scale into two parts: an extension scale and a primary scale. Use the primary scale, located to the right of the zero, to measure full units; use the extension scale, located to the left of the zero, to measure tenths of a unit. Read the extension scale right to left from the zero and the primary scale left to right from the zero (see Illustration 2.5.1).

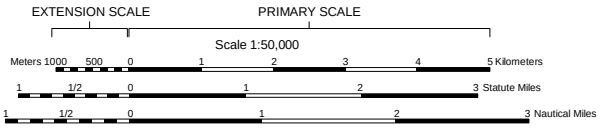


Illustration 2.5.1

Most road maps indicate distance in miles along primary roads between towns, road junctions, or dots. However, this is not the case with topographic maps. When using a topographic map, you must determine the distance between two points because it is not given. To accomplish this, you must first measure the map distance, then convert that measurement to actual ground distance. Using the bar scales is the best way to perform this task.

MEASURING STRAIGHT-LINE DISTANCE

To determine a straight-line distance between two points on a map, lay a straight-edged piece of paper on the map so that the edge of the paper touches both points and extends past them. Make a mark on the edge of the paper at the **center of mass** for each point (see Illustration 2.5.2)

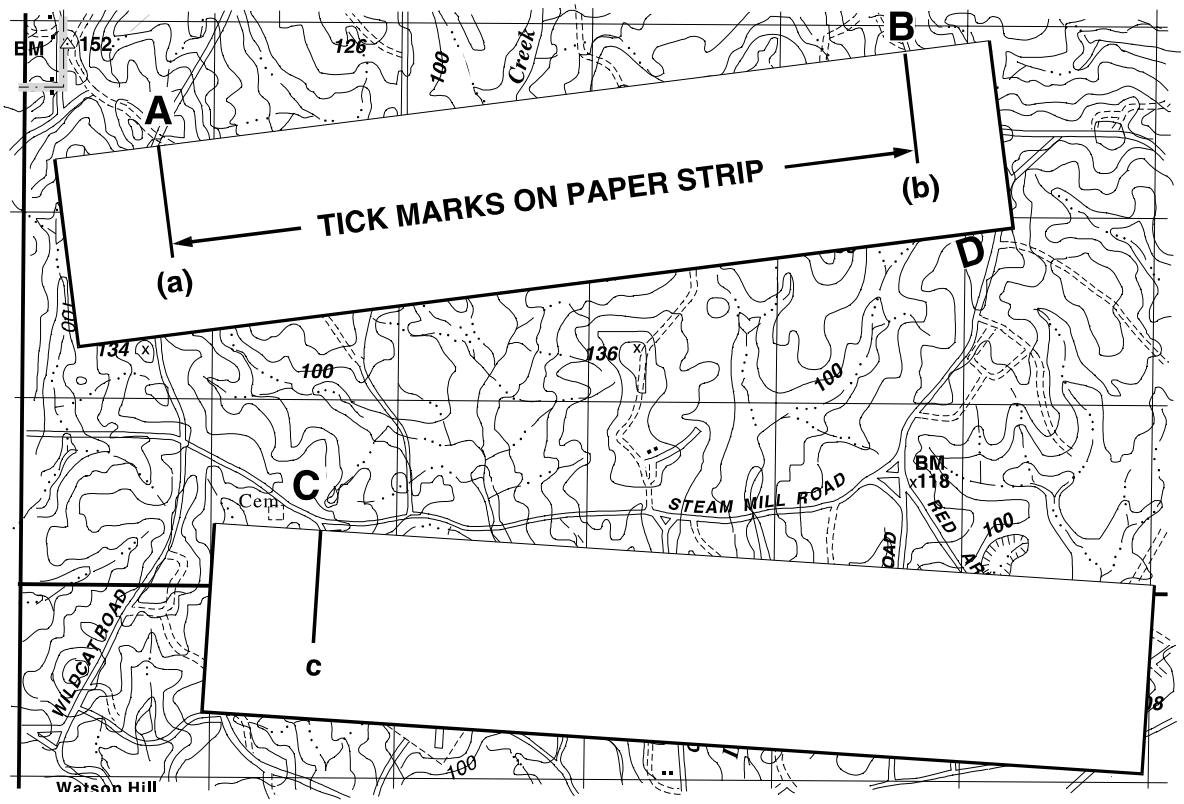


Illustration 2.5.2

To convert the map distance to ground distance, move the paper down to the graphic bar scale, and align the right mark (b) with a printed number on the primary scale so that the left mark (a) is in the extension scale. (See Illustration 2.5.3).

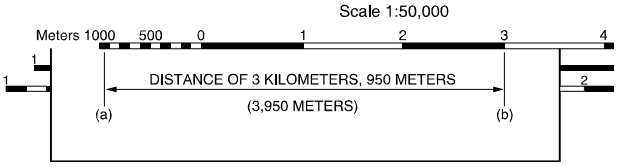


Illustration 2.5.3

In this example, we aligned the right mark (b) with the 3,000-meter mark on the primary scale; thus, the distance is at least 3,000 meters.

Now, to determine the distance between those two points to the nearest 10 meters, look at the extension scale. Since mapmakers number the extension scale with zero at the right and increasing to the left, always read this scale from right to left. Notice that each alternating shaded and clear rectangle is equal to 100 meters. To determine the distance from the zero to mark (a):

⇒ Count the number of whole shaded and clear 100 meter rectangles. In our example, there are nine of them, representing 900 meters.

⇒ Next, mentally divide the distance inside the rectangle containing mark (a) into tenths (or 10-meter intervals) — see Illustration 2.5.4. Since mark (a) is approximately half the distance of that rectangle, or five-tenths, you would add another 50 meters to the total in the first step.

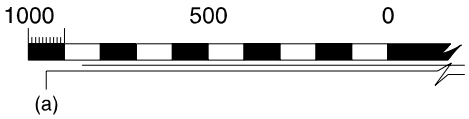


Illustration 2.5.4

Complete your calculations by adding the distance of 3,000 meters (determined using the primary scale) to the 950 meters (determined using the extension scale) the total distance between points (a) and (b) is 3,950 meters.

MEASURING CURVED LINES

To measure a distance along a winding road, stream, or any other curved line, you must first decide on which side of the feature to take your measurement. Never measure from side to side or down the middle. Start by making a mark on the straight-edged paper at the beginning point's center of mass. Move the edge of this paper along the curve, making marks at short straight distances on both the paper and the map as you proceed.

For accurate results, after placing a mark on both the paper and map, proceed to the next straight portion of this distance by pivoting the paper until the edge of the paper and area you are measuring are aligned. Use your pencil to hold the straight-edged paper in place while pivoting. Continue in this manner until you reach the center of mass at the ending point. Then place the paper on the desired bar scale and read the distance between the beginning and ending marks.

In the next example, we will measure the road distance between two points once again, by marking the beginning point (c) on the straight-edged paper (see Illustration 2.5.2). Next, place marks on both the straight edge piece of paper and the map for each straight portion of road between points (c) and (d). Pivot the straight-edged paper as you make the marks on the paper and map until you reach point (d) — see Illustration 2.5.5.

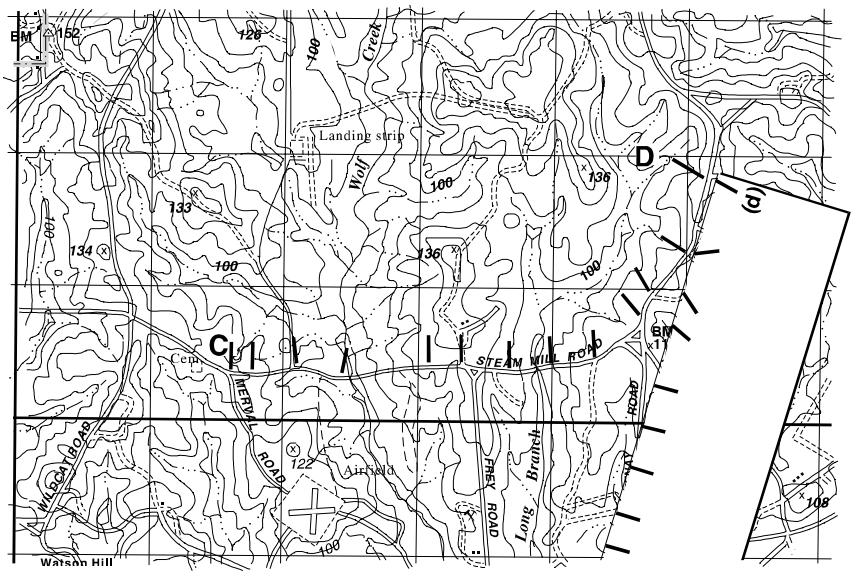


Illustration 2.5.5

Place the straight-edged paper on the correct bar scale. Using only the beginning and ending marks (ignoring the ones in between), calculate the total distance. You can now use the same method as in the previous example. Notice in Illustration 2.5.6 that point (d) falls on the 4,000 meter mark on the primary scale and point (c) is closest to the 550 meter reading on the extension scale. Thus, the road distance between points (c) and (d) is 4,550 meters.

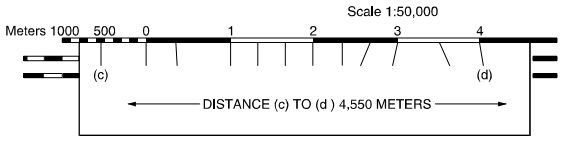


Illustration 2.5.6

CALCULATING DISTANCE THAT EXCEEDS THE SCALE

There may be times when the distance you measure on the edge of the paper exceeds the graphic scale, as in Illustration 2.5.7. When this happens, there is a procedure you can follow to measure this distance. The first step is to align the right mark (b) with the last printed number on the primary scale, in this case — 5 kilometers.

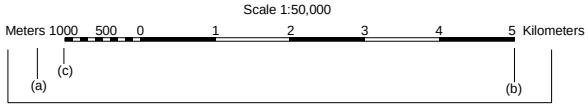


Illustration 2.5.7

When you include the 1000 meters in the extension scale, you can see that the distance from point (a) to (b) is more than 6,000 meters (or 6 kilometers). To determine the exact distance to the nearest 10 meters, place another mark (c) on the edge of the paper at the end of the extension scale. Remember that the distance from point (b) to (c) is 6,000 meters.

Slide the paper to the right to align mark (c) with zero, then measure the distance between marks (a) and (c). Since the distance between marks (a) and (c) is 420 meters, the total ground distance between start and finish points is 6,420 meters (see Illustration 2.5.8).

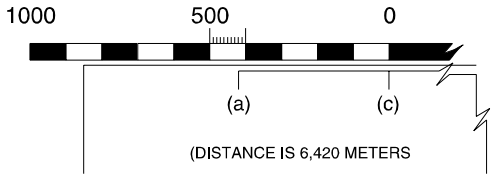


Illustration 2.5.8

CALCULATING DISTANCE TO A POINT OFF THE MAP

To determine distance to a point off the map, measure the distance (straight-line or curved-line) from the start point to the edge of the map. Check to see if the marginal information gives the road distance from the edge of the map to the point you want. Oftentimes, maps will give distances to towns, highways, or junctions off the map. Then, add the distance measured on the map to the distance given in the marginal information. Ensure that the unit of measure is the same. When measuring distance in **statute** or **nautical miles**, round it off to the nearest one-tenth of a mile.

Note: Distance measured on a map does not take into consideration the rise and fall of the land. All distances measured by using the map and graphic scales are flat distances. Therefore, the distance measured on a map will increase when actually measured on the ground. You must take this into consideration when navigating across country.

OTHER METHODS OF DETERMINING DISTANCE

PACE COUNT

One method used to measure ground distance is the pace count. A pace is equal to one natural step, about 30 inches long. In order to accurately use a pace count, you must know how many paces it takes you to walk 100 meters. To determine this, you must walk an accurately measured course and count the number of paces (steps) it takes. The pace course must be on terrain similar to that over which you will be walking. It will not help you very much to walk a course on flat terrain and then try to use that pace count on hilly terrain. Additionally, you may have to adjust your pace count because of the following conditions:

- *Slopes*. Your pace will lengthen on a downslope and shorten on an upgrade.
- *Winds*. A head wind shortens the pace and a tail wind increases it.
- *Surfaces*. Sand, gravel, mud, snow, and similar surfaces tend to shorten your pace.
- *Elements*. Snow, rain, or ice may cause you to reduce the length of your pace.
- *Clothing*. Excess clothing and shoes with poor traction can also affect the pace length.
- *Visibility*. Poor visibility, such as fog, rain, or darkness, can shorten your pace.

There are several methods to keep track of the distance you travel when using a pace count. Some of the most common methods are:

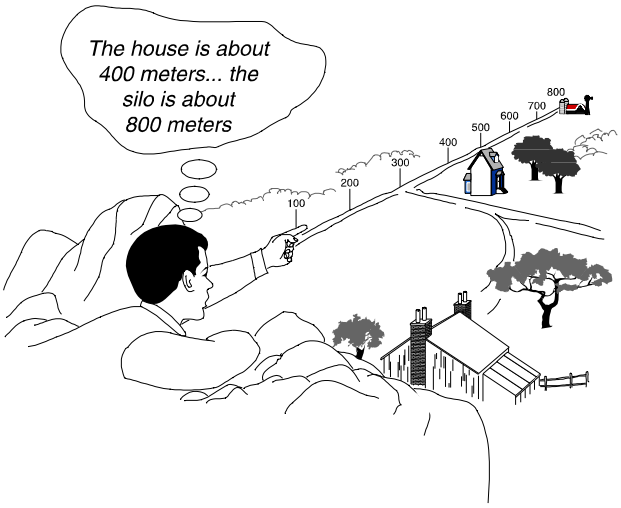
- Put a pebble in your pocket every time you have walked 100 meters according to your pace count.
- Tie knots in a string, (one for every 100 meters)
- Put marks in a notebook, (one for every 100 meters)

Never try to remember the count; always use one of the methods listed above, or design your own method.

ESTIMATION

Another method is to use estimation. To effectively use this method, you must be able to

visualize a distance of 100 meters on the ground. For distances up to 500 meters, determine the number of 100 meter increments between the two objects you wish to measure. Beyond 500 meters, select a point halfway to the objects and determine the number of 100 meter increments to the halfway point, then double it to find the distance to the objects.



CONCLUSION

In this lesson, we described several methods for determining distance and presented them in their order of accuracy. The most accurate method is to use a map scale and to convert the map distance (straight-line or curved-line) to ground distance. However, other ways of determining distance on the ground are by pacing and estimation. Estimation is the least accurate means of determining distance.

* * *

LESSON 6: DETERMINING DIRECTION

PURPOSE

Directions play an important role in everyday life. People oftentimes express them as right, left, straight ahead, and so forth; but then the question arises, "to the right of what?" To answer that question, this lesson first defines different types of azimuths and three different types of north, then it explains how to determine grid and magnetic azimuths using a protractor and compass.

azimuth
back azimuth
degree
graduated
grid azimuth
grid north
magnetic azimuth
magnetic north
mil (s)
true north

INTRODUCTION

In the last lesson, you learned how to determine the distance between two points. Once you have determined this distance, you have part of the information you need to get where you are going. In order to reach your destination, however, you still need to know what direction to travel.

EXPRESSING DIRECTIONS

We express direction as a unit of angular measure. The most common unit of measure is the **degree**. There are 360 degrees in a circle. Each degree is subdivided into 60 minutes and each minute into 60 seconds.

To express direction as a unit of angular measure, there must be a starting point (or zero measurement) and a point of reference. These two points designate the base direction or reference line. There are three base directions — **true north**, **magnetic north**, and **grid north**. Although you will only be using magnetic and grid north in this lesson, we have defined and illustrated all three base directions below.

- True north is a line from any point on the earth's surface to the north pole. All lines of longitude are true north lines. Mapmakers normally represent true north in the marginal information with a star .

- Magnetic north is the direction to the north magnetic pole, as shown by the north-seeking needle of a compass or other magnetic instrument. Mapmakers usually illustrate magnetic north in the marginal information by a line ending with a half arrow-head.

- Grid north is the north that mapmakers establish with the vertical grid lines on a map. They usually illustrate it by placing the letters "GN" on a vertical line in the marginal information.

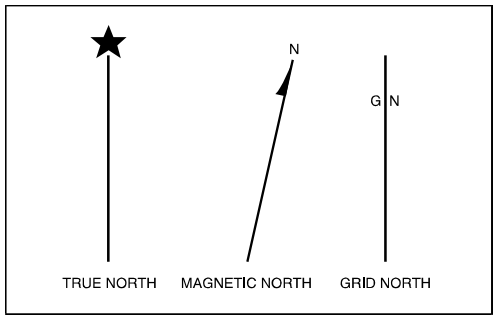


Illustration 2.6.1

AZIMUTHS

An **azimuth** is defined as a horizontal angle measured clockwise from a base direction. The azimuth is the most common military method to express direction. When using an azimuth, the point from which the azimuth originates is the center of an imaginary circle (see Illustration 2.6.2).

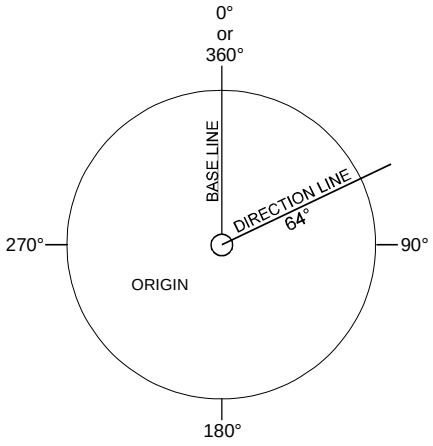


Illustration 2.6.2

There are three distinct ways to express an azimuth: **back azimuth**, **magnetic azimuth**, and **grid azimuth**. Following the definition of these azimuths, the remainder of this lesson will explain how to measure magnetic and grid azimuths.

- A back azimuth is the opposite direction of an azimuth. It is just like doing an "about face." To obtain a back azimuth from an azimuth, *add* 180 degrees if the azimuth is 180 degrees or less; or *subtract* 180 degrees if the azimuth is 180 degrees or more (see Illustration 2.6.3). The back azimuth of 180 degrees may be stated as 0 degrees or as 360 degrees.

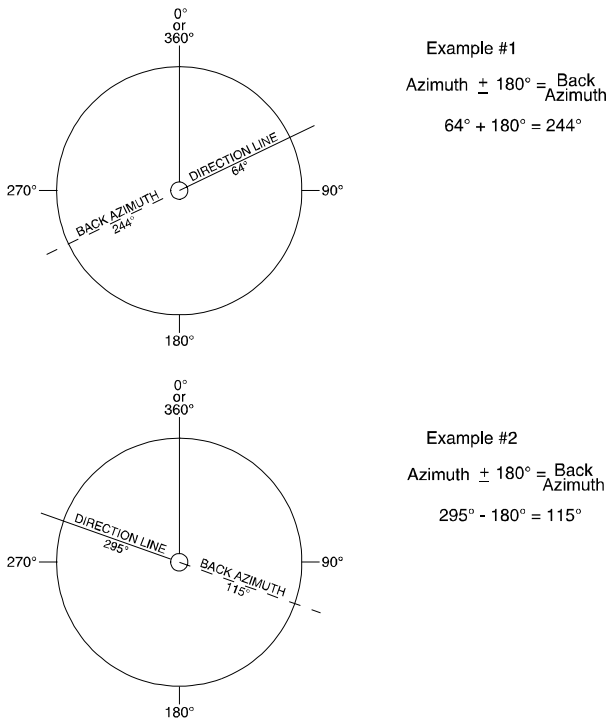


Illustration 2.6.3

- A magnetic azimuth is a direction expressed as the angular difference between magnetic north and the direction line (see Illustration 2.6.4). We determine a magnetic azimuth using a compass or other magnetic instrument (such as surveying equipment).

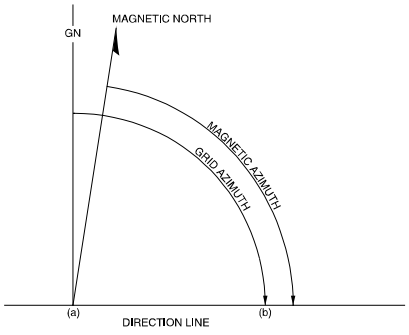


Illustration 2.6.4

- A grid azimuth is the angle measured between grid north and a straight line plotted between two points on a map (see points "a" and "b" in Illustration 2.6.4).

You would use a protractor to measure this angle.

TYPES OF COMPASSES

The Magnetic Lensatic Compass

You determine a magnetic azimuth with the use of a compass. However, before explaining how to measure a magnetic azimuth, we will first introduce you to two types of compasses. The magnetic lensatic compass (see Illustration 2.6.5), used by the military, is the most common and simplest instrument for measuring direction. It has three major parts: cover, base, and lens.

- Cover. The cover protects the floating dial. It contains the sighting wire (front sight) and two luminous sighting slots or dots used for night navigation.

- Base. The base contains the following movable parts.

⇒ The floating dial is mounted on a pivot so it can rotate freely when you hold the compass level. Printed on the dial in luminous figures are an arrow and the letters E and W or E, W, and S. The arrow always points to magnetic north and the letters fall at East (90 degrees), South (180 degrees), and/or West (270 degrees). There are two scales. The outer denotes **mils** and the inner scale (normally in red) denotes degrees.

⇒ Encasing the floating dial is a glass containing a fixed black index line.

⇒ The bezel ring is a ratchet device that clicks when turned. It contains 120 clicks when rotated fully. Each click is equal to 3 degrees. A short luminous line used in conjunction with the north-seeking arrow is contained in the glass face of the bezel ring.

⇒ The base also contains the thumb loop.

- Lens. Use the lens to read the dial. The rear sight also serves as a lock and clamps the dial when closed. You must open the rear sight more than 45 degrees to allow the dial to float freely. There is also a rear-sight slot used for sighting on objects. Use this with the front sight sighting wire.

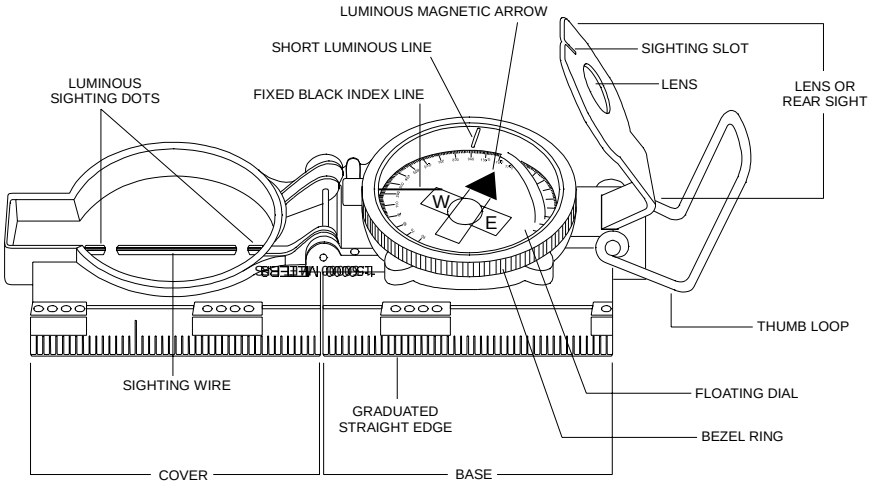


Illustration 2.6.5

The Silva Compass

The *Silva Polaris* (*Type 7*) precision compass (see Illustration 2.6.6) is also one of the most accurate compasses on the market today. Some high schools prefer it over the military issued, magnetic lensatic compass due to its cost and availability. The *Silva* compass is easy to use, especially with its hand-contoured base plate. It is typically available at certain discount department stores for just under $10. Shown below is the actual size of the *Silva Polaris* (*Type 7*) compass along with its eight features.

⇒ The floating needle is mounted on a pivot so that it can rotate freely when you hold the compass level. It settles within four seconds, always pointing to magnetic north.

⇒ Printed distinctly on the rotating dial are the letters N and S, to represent 0/360 degrees and 180 degrees, respectively. The dial is graduated at two degree intervals, marked at 20 degree intervals, and contains the letters E (at 90 degrees) and W (at 270 degrees).

⇒ The base plate contains two rulers (one measured in inches and the other in millimeters). It also has a 40-degree east and west declination scale inside the area of the floating dial.

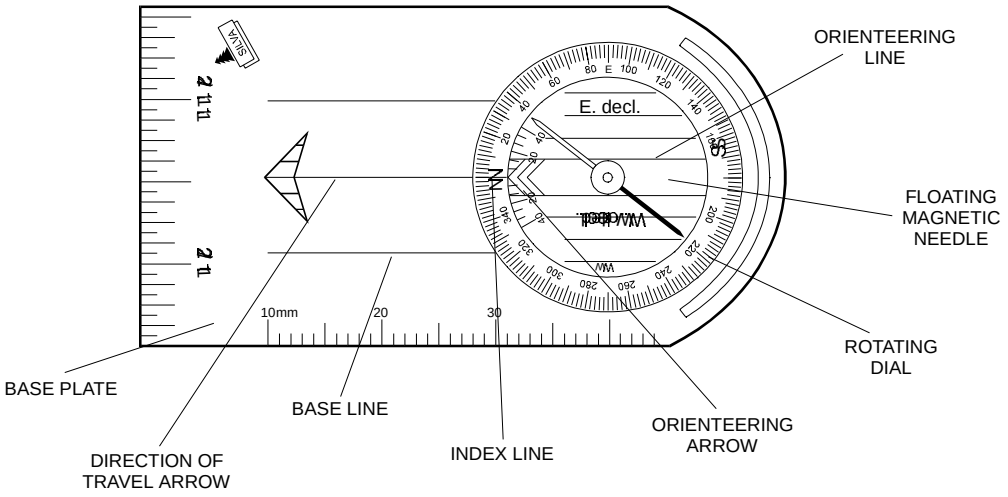


Illustration 2.6.6

MEASURING A MAGNETIC AZIMUTH

The following steps explain how to determine a magnetic azimuth using the centerhold technique (see Illustration 2.6.7). This method is the fastest and easiest way to measure a magnetic azimuth. There is also a compass-to-cheek technique as well as ways for presetting a compass; however, we will not cover those procedures in this unit.

1. First, open the compass to its fullest so that the cover forms a straightedge with the base.

2. Move the lens (rear sight) to the rearmost position, allowing the dial to float freely.

3. Next, place your thumb through the thumb loop, form a steady base with your third and fourth fingers, and extend your index finger along the side of the compass. Place the

thumb of the other hand between the lens (rear sight) and the bezel ring. Extend the index finger along the remaining side of the compass, and the remaining fingers around the fingers of the other hand.

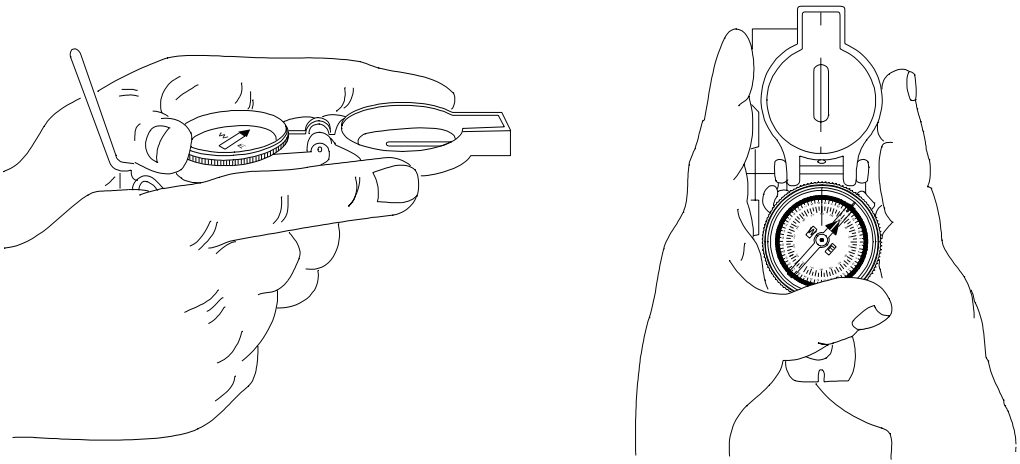


Illustration 2.6.7

4. Pull your elbows firmly into your sides. This action will place the compass between your chin and waist.

5. To measure an azimuth, simply turn your entire body toward the object, pointing the compass cover (zero or index mark) directly at the object.

6. Once you are pointing at the object, look down and read the azimuth from beneath the fixed black index line. Illustration 2.6.8 shows a magnetic azimuth of 320 degrees.

IMPORTANT NOTES:

- The six steps discussed above are for the magnetic lensatic compass. For the *Silva* compass, modify step 3 to hold it either completely in one hand (with the curved end toward the back of the palm) or with both hands (as shown in Illustration 2.6.7, but disregarding the information on thumb loop and rear sight.

- Ensure that you are away from power lines, vehicles, or other metal objects when using a compass because these objects will affect its accuracy.

- Some compasses may have a 1:25,000 scale; you can still use this scale with a 1:50,000 scale map, but you must halve the values read.

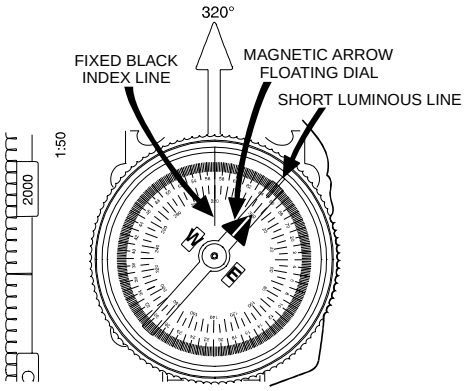


Illustration 2.6.8

USING PROTRACTORS

You determine a grid azimuth with the use of a protractor. There are several types of protractors: full circle, half circle, square, or rectangular. All of them divide the circle into units of angular measure, and each has a scale around the outer edge and an index mark. The index is the center of the protractor circle from which you measure all directions.

On the military protractor, you read the inner of two scales because it is **graduated** into degrees — from 0 to 360 degrees. Each tick mark on the degree scale represents one degree. The base line of this protractor is a line from 0 degrees to 180 degrees. Where the base line intersects the horizontal line, between 90 degrees and 270 degrees, is the index or center of the protractor.

When using the protractor, the base line is always oriented parallel to a north-south grid line. The 0- or 360-degree mark is toward the top or north on the map, and the 90-degree mark is to the right. Steps for determining and plotting grid azimuths are explained below.

MEASURING A GRID AZIMUTH

The following steps explain how to measure a grid azimuth using a map and protractor (see Illustration 2.6.9).

1. Draw a line connecting the two points (A and B on Illustration 2.6.9).

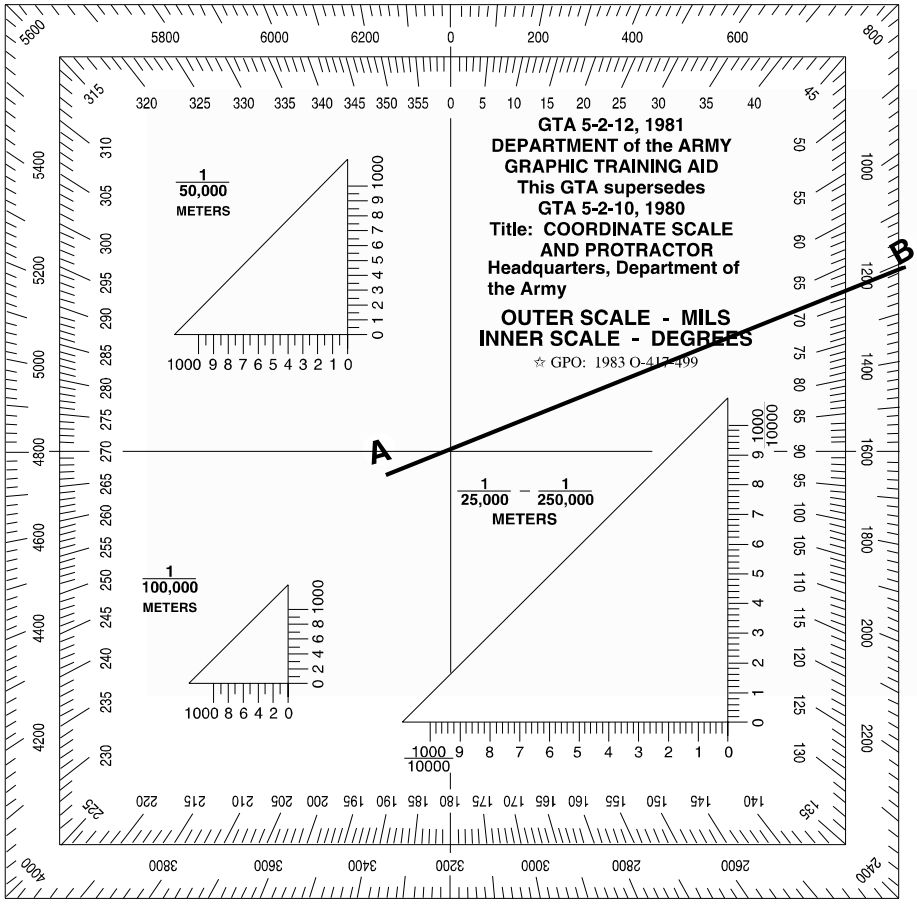


Illustration 2.6.9

2. Place the index of the protractor at the point where the drawn line crosses a vertical (north-south) grid line.

3. Keep the index at that point and align the 0 – 180 degree line of the protractor on the vertical grid line.

4. Read the value of the angle from the scale. This value is the grid azimuth from point A to point B, or 68 degrees in our example.

PLOTTING A GRID AZIMUTH

Use the following steps to plot an azimuth from a known point on a map (see Illustration 2.6.10). For this example, you will not have to convert the azimuth from magnetic to grid.

1. Place the protractor on the map with the index mark at the center of mass of the known point and the 0 – 180 degree base line parallel to a north-south grid line. (Use BM 145 on State Route 103.)

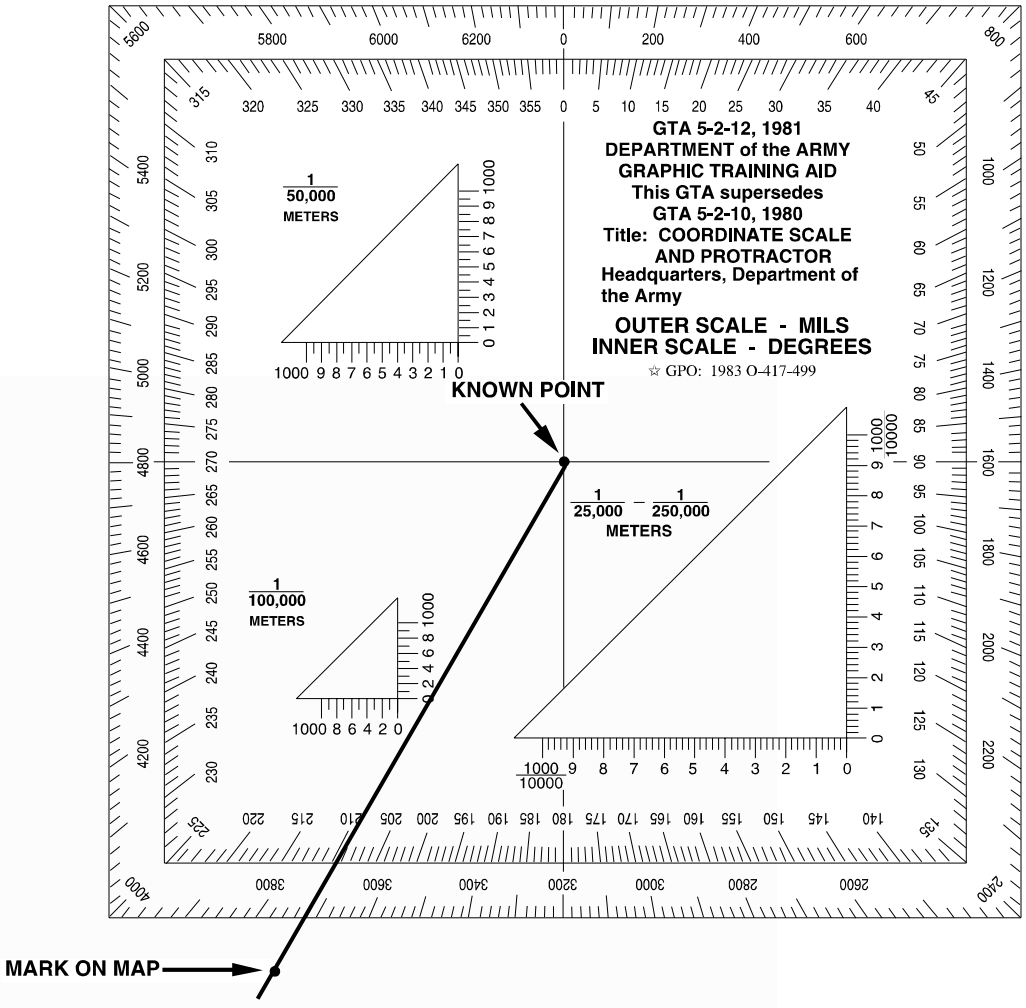


Illustration 2.6.10

2. Make a mark on the map at the desired azimuth. (Use an azimuth of 210 degrees.)

3. Remove the protractor and draw a line connecting the known point and the mark on the map. This is the grid direction line or grid azimuth. (**NOTE:** Distance has no effect on azimuths.)

PROCEED WITH CAUTION!

When measuring azimuths on a map, remember that you are measuring from a starting point to an ending point. If you make a mistake and you take the reading from the ending point, the grid azimuth will be opposite, thus causing you to go in the wrong direction.

CONCLUSION

Regardless of where you live, you need a way of expressing direction that is accurate and has a common unit of measure. Simply expressing, “to the right of that ...,” may not be sufficient. The use of azimuths, compasses, protractors, and maps, will improve the accuracy of your directions.

LESSON 7: CONVERTING THE GRID-MAGNETIC ANGLE

PURPOSE

In this lesson, we will show you how to use the **declination** diagram to convert grid azimuths to magnetic azimuths and vice versa. Converting the **Grid-Magnetic Angle** is one of the most difficult tasks to understand in map reading. Therefore, this lesson presents simple step-by-step procedures for converting the G-M angle.

arc
declination
grid convergence
Grid-Magnetic (G-M) Angle

THE DECLINATION DIAGRAM

Mapmakers place the declination diagram in the lower margin of most topographic maps.

Declination is the angular difference between true north and either magnetic or grid north. There are two declinations, a magnetic declination and a grid declination. The declination diagram shows the angular relationship, represented by prongs, between the three norths (see Illustration 2.7.1). However, the position of the three prongs in relation to each other varies according to the declination data for each map.

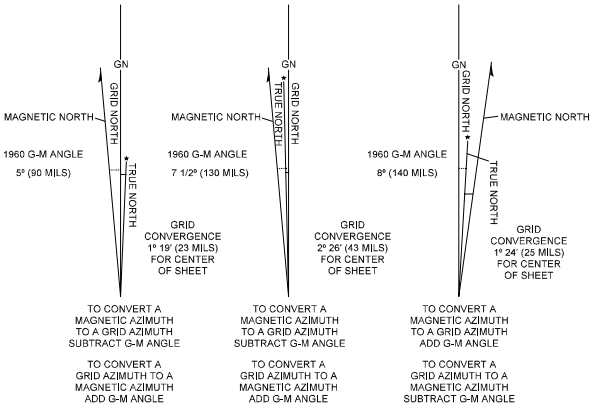


Illustration 2.7.1

Furthermore, mapmakers usually do not plot the angles between the prongs exactly to scale. Although you can obtain the position of the norths in relation to each other from the diagram, you should not measure the numerical value from it. For example, if the amount of declination from grid north to magnetic north is one degree, the **arc** shown on the diagram only represents the direction of the declination and the diagram may exaggerate its value. If measured, the declination may have an actual value of five degrees.

THE GRID-MAGNETIC (G-M) ANGLE

The Grid-Magnetic Angle, or the G-M angle, is the angular size that exists between grid north and magnetic north in the year that mapmakers prepared the angular size. It is an arc, indicated by a dashed line, that connects the grid-north and magnetic-north prongs. Maps express this value to the nearest one-half (1/2) degree with mil equivalents shown to the nearest 10 mils. The G-M angle is important in map reading because it helps a user to apply direction to an object that is on a map to its actual direction on the ground and vice versa.

GRID CONVERGENCE

The **grid convergence** is an arc indicated by a dashed line connecting the prongs

for true north and grid north. The value of the angle for the center of the sheet is given to the nearest full minute (of degrees) with its equivalent to the nearest mil. Mapmakers show these data in the form of a grid-convergence note.

CONVERSION

There is an angular difference between the grid north and the magnetic north caused by the attraction of the earth's magnetic field (found in Northern Canada). Since all compasses point toward magnetic north, the location of this magnetic field does not match exactly with the grid-north lines on the maps. Therefore, a conversion from magnetic to grid, or vice versa, is needed.

Conversion With Notes

If the declination diagram on a map provides conversion notes explaining the use of the G-M angle, simply refer to them. One note gives instructions for converting a magnetic azimuth to a grid azimuth. The other shows how to convert a grid azimuth to a magnetic azimuth. The conversion (to add or subtract) depends on the direction of the magnetic-north prong relative to the grid-north prong.

Conversion Without Notes

Some maps, however, do not contain these declination conversion notes. Thus, it is necessary to convert from one type of declination to another. A magnetic compass gives a magnetic azimuth, but in order to plot this line on a map with grid lines, you must change the magnetic azimuth value to a grid azimuth value. Therefore, you must use the declination diagram for these conversions. A rule to follow when solving such problems is "starting from the reference line, always measure the angle to the azimuth line in a clockwise direction." With this rule in mind, you can now solve the problem using the following steps (see Illustration 2.7.2).

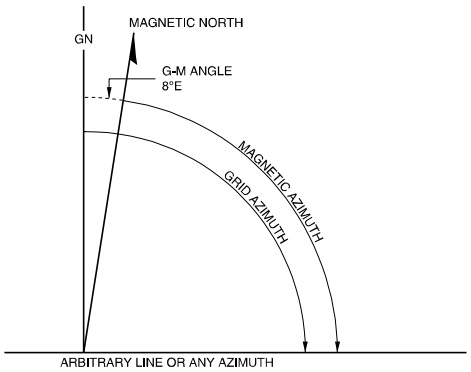


Illustration 2.7.2

1. Draw a vertical, or grid-north, line (prong). Always align this line with the vertical lines on the map.

> The first application will be to convert an east magnetic azimuth to a grid azimuth (see Illustration 2.7.3).

2. From the base of the grid-north line, draw a direction line (or an azimuth line) at roughly a right angle from north, regardless of the actual value of the azimuth in degrees.

3. Examine the declination diagram on the map and determine the direction of the magnetic north (right-left or east-west) relative to that of the grid-north prong. Draw a magnetic prong from the base of the grid-north line in the desired direction.

4. Determine the value of the G-M angle by drawing an arc from the grid prong to the magnetic prong and placing the value of the G-M angle above the arc.

5. Complete the diagram by drawing an arc from each reference line to the vertical line you first drew. A glance at the completed

diagram shows whether the given or desired azimuth is greater, and thus whether you must add or subtract the known difference between the two azimuths.

The second application will be to convert an east grid azimuth to a magnetic azimuth (see Illustration 2.7.4).

6. The inclusion of the true-north prong in relationship to the conversion is of little importance.

APPLICATIONS OF THE G-M ANGLE CONVERSION

For the remainder of this lesson, we will show you how to apply this conversion technique when you have an east G-M angle, a west G-M angle, and when the G-M angle is greater than the magnetic or grid azimuth. You will also have an opportunity to practice converting the G-M angle in the Chapter Review immediately following this lesson.

Working With an East G-M Angle

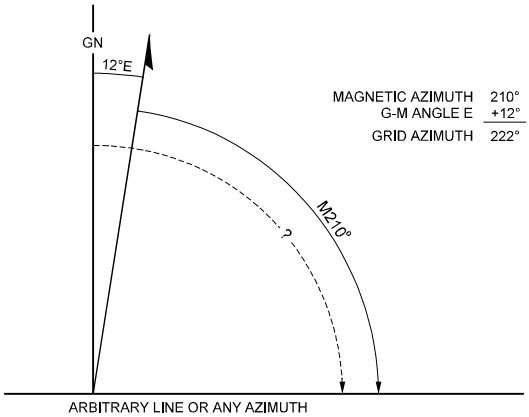


Illustration 2.7.3

To plot a magnetic azimuth of 210 degrees on a map, you must convert it to a grid azimuth.

1. First, determine the declination in degrees. In this example, it is 12 degrees east (see Illustration 2.7.3).

2. Then, since the arc from magnetic north to the azimuth line is shorter than the arc from grid north to the azimuth line, you must *add* the G-M angle. This yields a grid azimuth of 222 degrees.

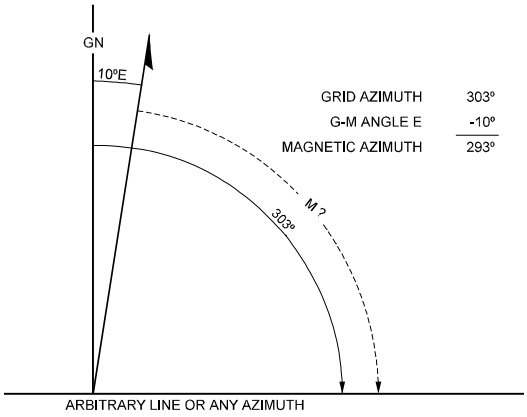


Illustration 2.7.4

To use a magnetic azimuth in the field with a compass when you have a grid azimuth of 303 degrees, you must convert it to a magnetic azimuth.

1. First, determine the declination in degrees. In this example, it is 10 degrees east (See Illustration 2.7.4).

2. Then, since the arc from grid north to the azimuth line is longer than the arc from magnetic north to the azimuth line, you must *subtract* the G-M angle. This yields a magnetic azimuth of 293 degrees.

The third application will be to convert to a magnetic azimuth when the G-M angle is greater (see Illustration 2.7.5).

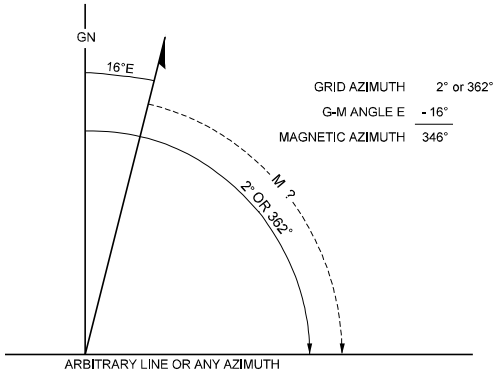


Illustration 2.7.5

In converting a grid azimuth to a magnetic azimuth, when the G-M angle is greater than the grid azimuth, first do the following:

1. Add 360 degrees to the grid azimuth. In this example, the grid azimuth is 2 degrees (see Illustration 2.7.5) (**Note:** Since there are no negative azimuths on the azimuth circle, 0 degrees is the same as 360 degrees. Therefore, 2 degrees [in this example] is the same as 362 degrees. This is because 2 degrees and 362 degrees are located at the same point on the azimuth circle.) You can now convert the grid azimuth to a magnetic azimuth because the grid azimuth is larger than the G-M angle.

2. This procedure is the same as Step 2 in the last example. Since the grid north arc of 362 degrees is longer than the arc from magnetic north to the azimuth line, you must *subtract* the G-M angle. This yields a magnetic azimuth of 346 degrees.

The fourth application will be to convert a west magnetic azimuth to a grid azimuth (see Illustration 2.7.6).

Working With a West G-M Angle

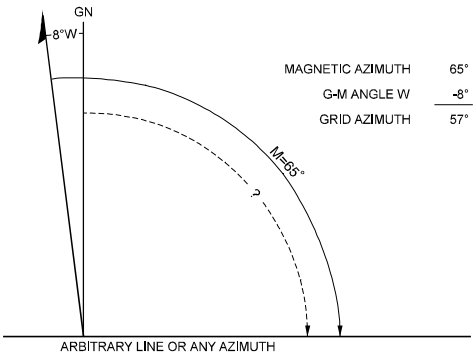


Illustration 2.7.6

To plot a magnetic azimuth of 65 degrees on a map, you must convert it to a grid azimuth.

1. First, determine the declination in degrees. In this example, it is 8 degrees west (see Illustration 2.7.6).

2. Then, since the arc from magnetic north to the azimuth line is longer than the arc from grid north to the azimuth line, you must *subtract* the G-M angle, giving you a grid azimuth of 57 degrees.

To use a magnetic azimuth in the field with a compass when you have a grid azimuth of 93 degrees, you must convert it to a magnetic azimuth.

The fifth application will be to convert a west grid azimuth to a magnetic azimuth (see Illustration 2.7.7).

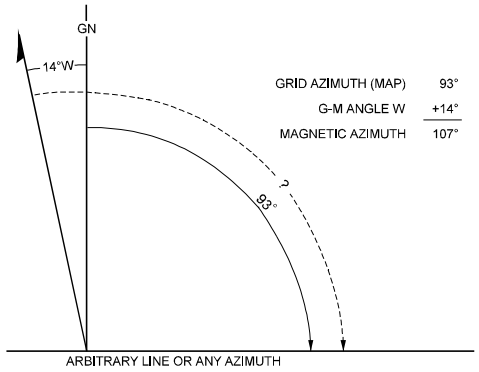


Illustration 2.7.7

1. First, determine the declination in degrees. In this example, it is 14 degrees west (see Illustration 2.7.7).

2. Then, since the arc from grid north to the azimuth line is shorter than the arc from magnetic north to the azimuth line, you must *add* the G-M angle. This yields a magnetic azimuth of 107 degrees.

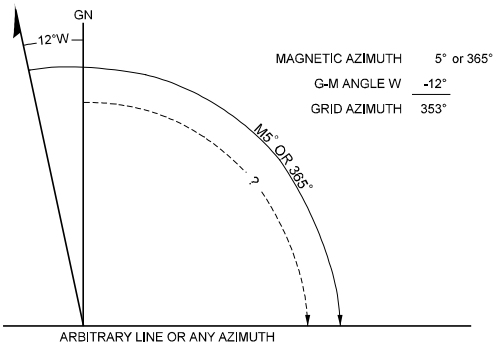


Illustration 2.7.8

In converting a magnetic azimuth to a grid azimuth, when the G-M angle is greater than the magnetic azimuth, first do the following:

1. Add 360 degrees to the magnetic azimuth. In this example, the magnetic azimuth is 5 degrees (see Illustration 2.7.8). (**Note:** Since there are no negative azimuths on the azimuth circle, 0 degrees is the same as 360 degrees. Therefore, 5 degrees [in this example] is the same as 365 degrees. This is because 5 degrees and 365 degrees are located at the same point on the azimuth circle.) You can now convert the magnetic azimuth to a grid azimuth because the magnetic azimuth is larger than the G-M angle.

2. Since the magnetic north arc of 365 degrees is longer than the arc from grid north to the azimuth line, you must *subtract* the G-M angle. This yields a grid azimuth of 353 degrees.

Each time you convert a G-M angle, construct a G-M angle diagram that shows the required azimuths. The construction of a diagram takes the guesswork out of converting azimuths when the map does not give any conversion notes.

> The final application will be to convert to a grid azimuth when the G-M angle is greater (see Illustration 2.7.8).

Converting the G-M angle requires practice. Become familiar with the proper procedures to follow whether there is an east or west G-M angle, or the G-M angle is greater than your grid or magnetic azimuth.

CONCLUSION

In this lesson, we presented map reading skills that you can use not only in later map reading instruction, but also in many practical ways. We discussed how to determine distance

and direction (with a protractor and a compass) between two points. We also investigated how to convert the Grid-Magnetic Angle using a grid azimuth from a map or a magnetic azimuth from a compass. Mastering these skills will help you to navigate more effectively when the challenge arises.

* * *

LESSON 8: DETERMINING LOCATION

PURPOSE

In this chapter, we have presented most of the basic map reading skills. However, skills such as determining an eight-digit grid coordinate, and locating an unknown point using **polar coordinates**, **intersection**, and **resection** will help you to more accurately locate and plot points on a map. This lesson examines those skills and gives you an opportunity to practice them. We will also show you how to determine direction using a **field-expedient** method.

field-expedient
intersection
polar coordinates
resection

INTRODUCTION

Sometimes it is not enough to know how to locate a point to within 1,000 or 100 meters, or to estimate the location of a distant point on the ground. There may be times when you have to determine your location, or a distant point, even more accurately. Or, perhaps you will need to use certain known locations as reference points. This lesson will help you to accomplish these tasks.

DETERMINING AN EIGHT-DIGIT GRID COORDINATE

To determine an eight-digit coordinate, you must use a coordinate scale. Keep in mind that there are 100 meters between each 100-meter mark (number) on the coordinate scale, with a short tick mark to indicate 50 meters between each 100-meter mark. To locate *Spot elevation (SE) 450* in Illustration 2.8.1 to within 10 meters, use the following procedures:

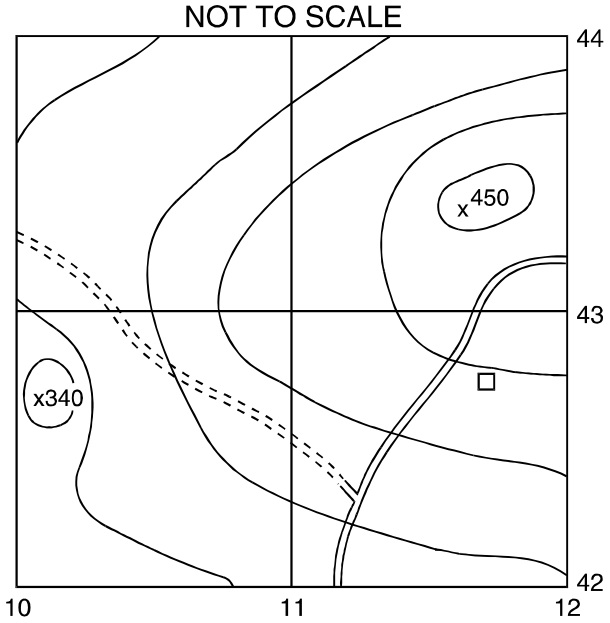


Illustration 2.8.1

1. Recall that you must first identify the 1,000 meter grid square in which the spot elevation is located. To do this, remember the first cardinal rule of map reading: *read right, then up*. When reading a map right and up, each north-south grid line increases in value from west to east, and each east-west grid line increases in value from south to north.

By reading right, the last north-south grid line before reaching the grid square containing *SE 450* is 11.

By reading up, the last east-west grid line before reaching the grid square containing *SE 450* is 43.

By adding the 100,000 meter square identifier (YF), YF1143 locates *SE 450* to the nearest 1,000 meters.

2. Next, place the coordinate scale parallel to and directly on top of grid line 43 with the "0 mark" at the lower left-hand corner of grid square YF1143 (see Illustration 2.8.2). (**Note:** Ensure that you are using the correct scale.)

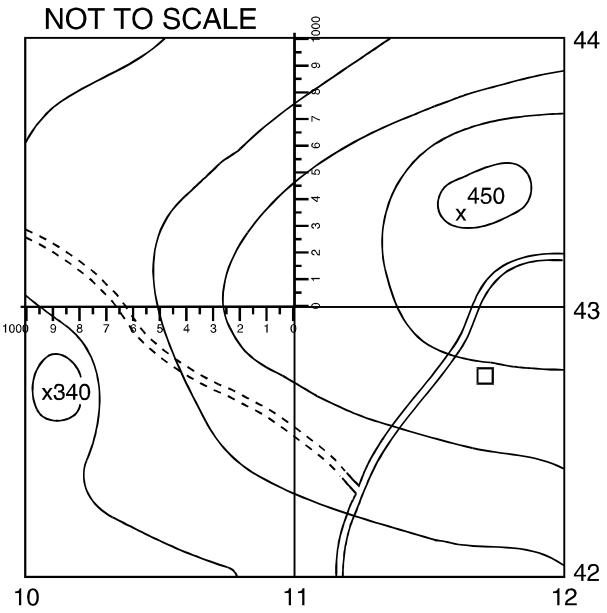


Illustration 2.8.2

3. Keeping the horizontal scale on top of the 43 grid line, slide the scale to the right into the grid square until the vertical scale intersects the center of mass of *SE 450* (see Illustration 2.8.3).

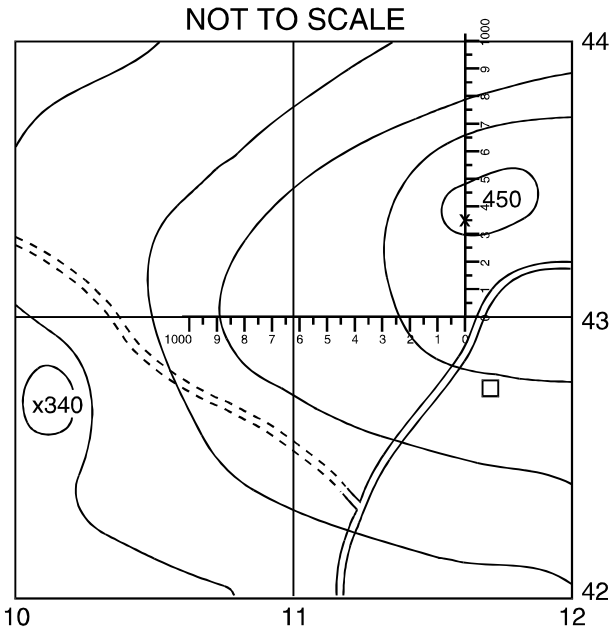


Illustration 2.8.3

4. Now, reading from the "0 mark," the *right* reading shows that *SE 450* lies between the 600 and 650 meter mark by approximately 30 meters. (**Note**: You determine that it is approximately 30 meters by estimating how many 10s *SE 450* is beyond the 600-meter mark. In this case, there are three, which gives you the third and fourth digits of the coordinate. Thus, the center of mass of *SE 450* is 630 meters into the grid square and we would read this number as 1163.

5. Reading *up*, you can see that *SE 450* lies midway between the 300 and 400 meter marks, or 350 meters into the grid square. Therefore, the up reading is 4335.

6. By combining both sets of numbers and adding the 100,000 meter square identifier, the location of *SE 450* is YF11634335. You have now correctly located a point to the nearest 10 meters.

To trace the degree of accuracy of an eight-digit grid coordinate from 1,000 to 10 meters, we can break it down as follows: (1) the underlined numbers in YF1163433 5, represent the 1,000 meter grid square and they locate the point to within 1,000 meters, (2) the third and seventh digits of YF1163433 5 denote 600 and 300 meters and locate the point to within 100 meters; and (3) the fourth and eighth digits of YF1163433 5 denote 30 and 50 meters and locate the point to within 10 meters.

INTERSECTION

You can use intersection to locate an unknown point by determining where the azimuths from two (preferably three) known positions on the ground intersect. There are two ways to determine intersection, the map and compass method and the straightedge method.

MAP AND COMPASS METHOD

The first way to find an unknown point by intersection is with a map and compass. Follow these procedures and Illustration D.

1. Orient the map using the compass.

DID YOU KNOW?

The best way to orient a map is to use a compass.

2. Determine the grid-magnetic angle (G-M angle) of the map you are using. *In this example, the G-M angle is 5 degrees east.*

3. Locate and mark your first known position *(Point A)* on the map.

4. Measure the magnetic azimuth to the unknown point from Point A using a compass. *In this example, the magnetic azimuth is 71 degrees.*

5. Convert the magnetic azimuth to a grid azimuth. *In this example, 71 degrees plus 5 degrees equals a 76-degree grid azimuth.*

6. Place the coordinate scale on the map, ensuring that the zero-degree indicator is at the top and the index point is directly over the center of mass of Point A. Place a tick mark at *76 degrees* on the map. Draw a line from Point A along this grid azimuth.

7. Move to *Point B* (the second known point) and locate it on the map. Then, repeat steps 4, 5, and 6. *For this example: (1) The magnetic azimuth in step 4 from Point B to the unknown point is 35 degrees. (2) Convert this to a grid azimuth using the formula 35 + 5 = 40 . (3) Place a tick mark at 40 degrees on the map and draw a line along that grid azimuth.*

8. The location of the unknown position is where the lines cross on the map. Determine the eight-digit grid coordinate for this position.

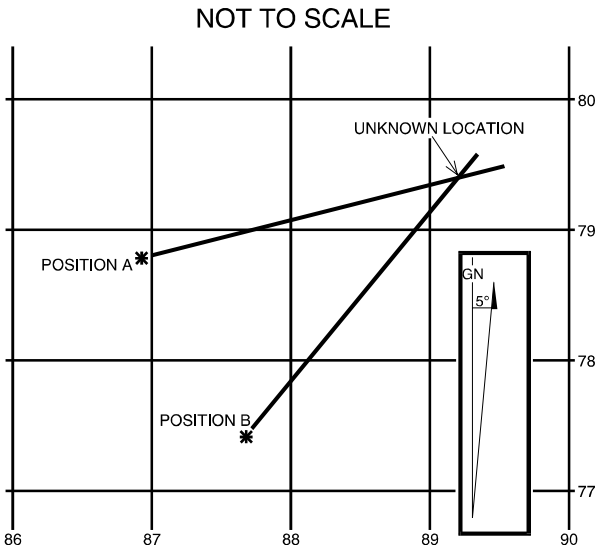


Illustration 2.8.4

STRAIGHTEDGE METHOD

The second way to locate an unknown point by intersection is by using a straightedge. Follow these procedures and Illustration 2.8.5.

1. Orient the map (on a flat surface) to the ground by terrain association.
2. Locate and mark your known position on the map (*Point A*).
3. Place a straightedge on the map with one end at your position (*Point A*) as a pivot point. Rotate the straightedge until the unknown point (*C*) is sighted along the edge.
4. Draw a line along the straightedge.
5. Repeat steps 3 and 4 with the second known position (*Point B*) and check for accuracy.
6. The intersection of these lines on the map is the location of the unknown point (C).
7. Determine the six or eight-digit grid coordinate (depending upon the desired degree of accuracy) for the unknown point.

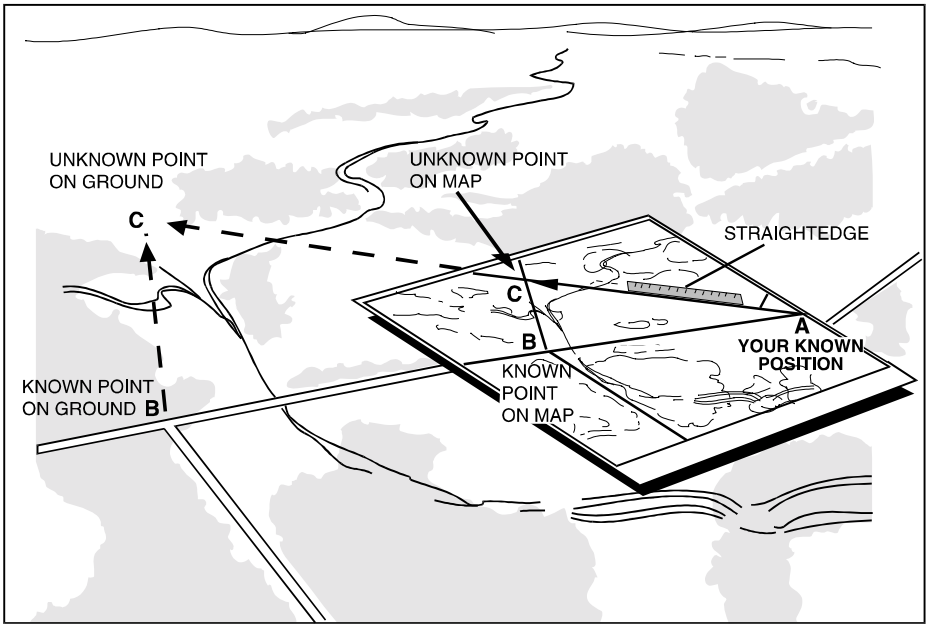


Illustration 2.8.5

RESECTION

You can use resection to locate your unknown position on a map by determining the grid azimuth to at least two well-defined locations on the map. For greater accuracy, the desired method of resection would be to use three well-defined locations. There are three ways you can use resection: the map and compass method, modified resection, and the straightedge method.

MAP AND COMPASS METHOD

The first way to find your unknown location by resection is with a map and compass. Follow these procedures and Illustration 2.8.6.

1. Orient the map using the compass.
2. Determine the grid-magnetic angle (G-M angle) of the map you are using. *In this example, the G-M angle is 3 degrees east.*

3. Identify two or three known locations on the ground; mark them on the map *(such as Hilltop 408 and the control tower).*

4. Measure the magnetic azimuth to one of the known positions from your location using a compass. *In this example, the magnetic azimuth to Hilltop 408 is 312 degrees*.

5. Convert the magnetic azimuth to a grid azimuth. *In this example, 312 degrees plus 3 degrees equals a 315-degree grid azimuth.*

6. Convert the grid azimuth to a back azimuth by adding or subtracting 180 degrees. *In this example, 315 degrees minus 180 degrees equals a 135-degree back azimuth*.

7. Place the coordinate scale on the map, ensuring that the zero-degree indicator is at the top and the index point is directly over the center of mass of the known point. Place a tick mark at 135 degrees. Draw a line on the map from the known position back toward your unknown location.

8. Repeat steps 4, 5, 6, and 7 for the second known position (*the control tower*). *For this example: (1) The magnetic azimuth to the control tower is 15 degrees. (2) Convert this to a grid azimuth: 15 + 3 = 18. (3) Convert this to a back azimuth: 18 + 180 = 198. (4) Place a tick mark at 198 degrees on the map and draw a line back toward your unknown location*.

9. The intersection of these two lines is your location. Determine the eight-digit grid coordinate for your position.

Note: You can use *modified resection* to locate your position on the map when you are at a linear feature on the ground, such as a road, canal, stream, etc. To do this, you need only one known location. Use the first seven steps above, then where the drawn line (in step 7) crosses the linear feature is your location.

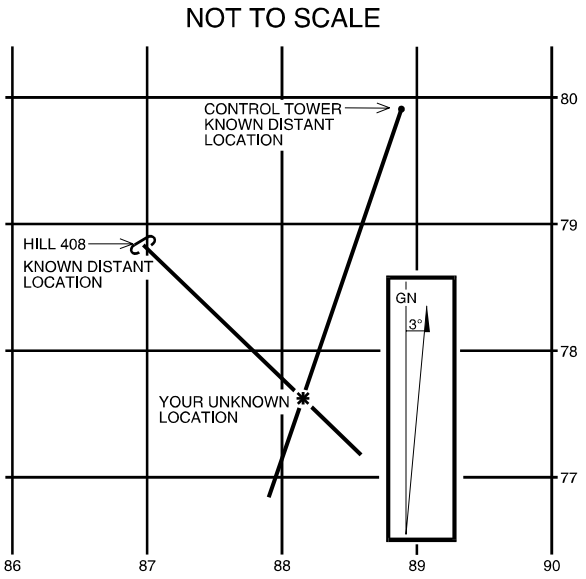


Illustration 2.8.6

STRAIGHTEDGE METHOD

Another way to locate your unknown position by resection is by using a straightedge. Follow these procedures and Illustration 2.8.7.

1. Orient the map (on a flat surface) to the ground by terrain association.

2. Locate at least two known distant locations or prominent features on the ground and mark them on the map (*Points A, B, and C*).

3. Place a straightedge on the map pointing toward one of the known points (*Point A*). Rotate the straightedge until the known point on the map is aligned with the same known point on the ground.

4. Draw a line along the straightedge away from the known point on the ground toward your position.

5. Repeat steps 3 and 4 using the other known points (*Points B and C*).

6. The intersection of these lines on the map is your location.

7. Determine the six or eight-digit grid coordinate (depending upon the desired degree of accuracy) for your location.

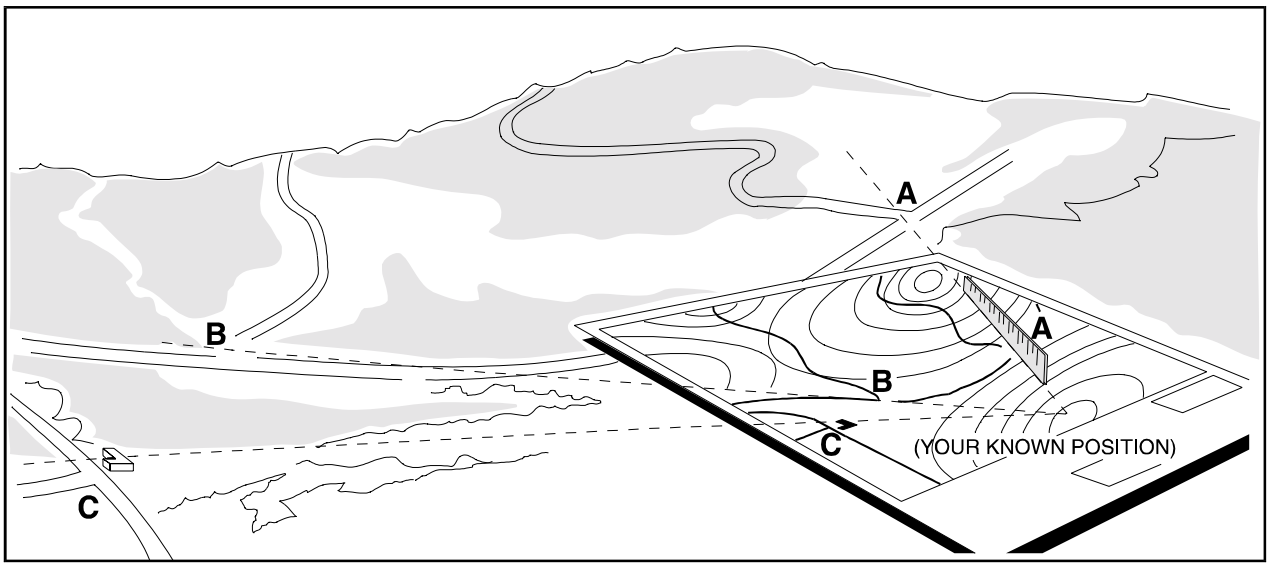


Illustration 2.8.7

POLAR COORDINATES

You can use polar coordinates to locate or plot an unknown point from a known location by giving a direction and a distance along the direction line. Three elements must be present to use polar coordinates: a known location on the map, an azimuth (grid or magnetic), and a distance (normally in meters). There are two ways that you can use polar coordinates, the map and compass method and the protractor method.

MAP AND COMPASS METHOD

Use the procedures below and Illustration 2.8.8 for the map and compass method.

1. Orient the map using a compass.

2. Determine the grid-magnetic angle (G-M angle) of the map you are using. *In this example, the G-M angle is 0 degrees*.

3. Identify the known location on the ground and mark it on the map. *In this example, the known location is the water tank in grid square FL4526*.

4. Measure the magnetic azimuth to the unknown point (*a building in grid square FL4729*) from the known location using a compass. *In this example, the magnetic azimuth to building is 24 degrees*.

5. Convert the magnetic azimuth to a grid azimuth. *In this example, 24 degrees plus 0 degrees equals a 24-degree grid azimuth*.

6. Place a coordinate scale on the map, ensuring that the zero-degree indicator is at the top and the index point is directly over the center of mass of the known point. Place a tick mark at 24 degrees. Draw a line on the map from the known location along this grid azimuth until it intersects the building.

7. Determine the distance to the unknown position. *Using a straightedge and the procedure for measuring straight line distance, you determine the distance to the building in grid square FL4729 to be 3,600 meters*.

PROTRACTOR METHOD

The second way to locate or plot an unknown point from a known location using polar coordinates is the protractor method. Follow these procedures below and Illustration 2.8.8.

1. Determine the location of a known point on the map to within 100 or 10 meters. *In this example, the known location is the water tank at grid coordinates FL45952610*.
2. Measure a grid azimuth to the desired location or destination (the building in grid square FL4729). *By using your protractor, you determine the grid azimuth to be 24 degrees to the building*.
3. Determine the distance as you did in step 7 of the map and compass method.

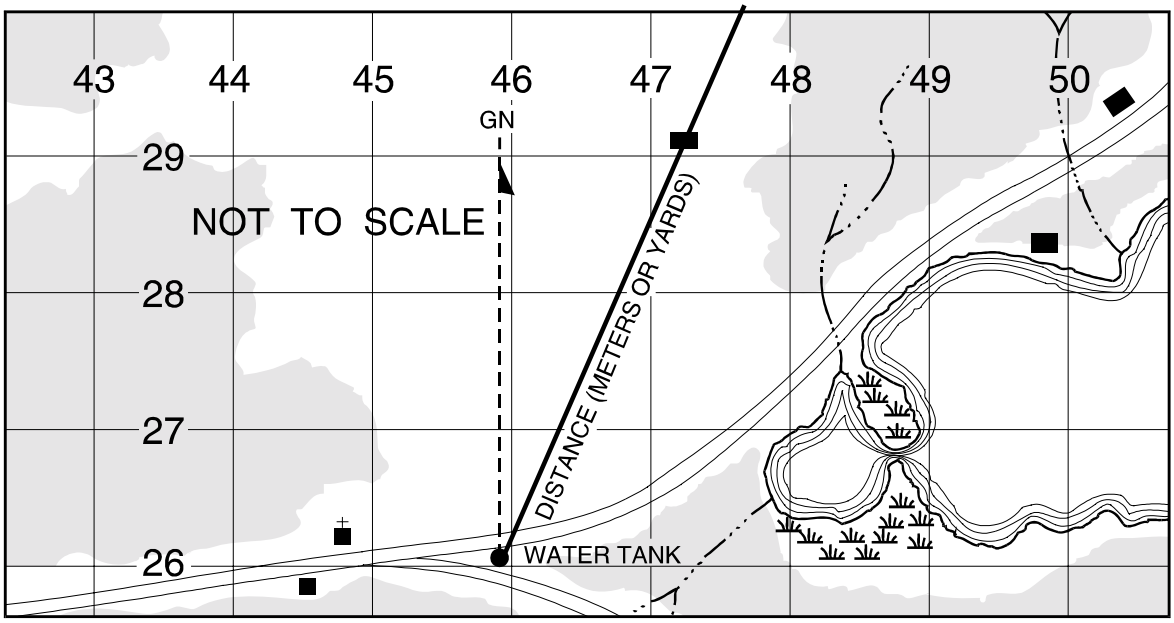


Illustration 2.8.8

DETERMINE DIRECTION USING FIELD-EXPEDIENT METHODS

SHADOW-TIP METHOD

The five easy-to-follow steps explained below will show you how to use the shadow-tip method to determine direction and/or orient a map without a compass.

1. Place a stick or branch (at least 12 inches long) vertically into the ground at a fairly level spot where the sun will cast a distinct shadow. Mark the shadow tip on the ground with a small stone, twig, or other means. See Illustration 2.8.9.

Note: If the tip of the shadow is difficult to find, tap the end of the stick; the movement of the shadow will help you locate it.

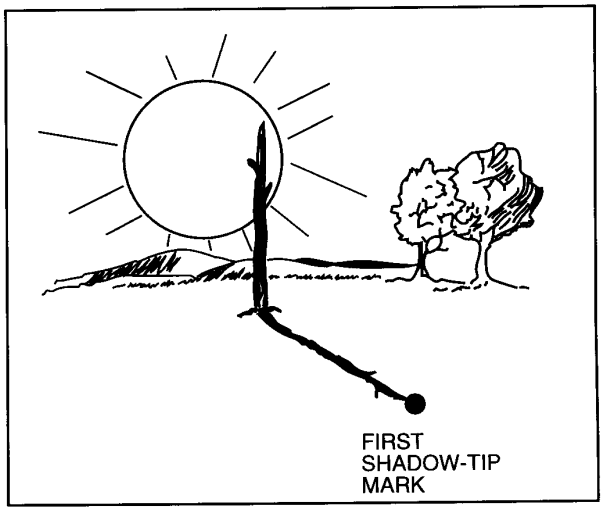


Illustration 2.8.9

2. Wait about 10 or 15 minutes until the shadow moves a few inches. Mark the new position of the shadow tip in the same way as the first. See Illustration 2.8.10.

3. Draw a straight line through the two marks to obtain an east-west line. Extend this line past the second mark. See Illustration 2.8.10.

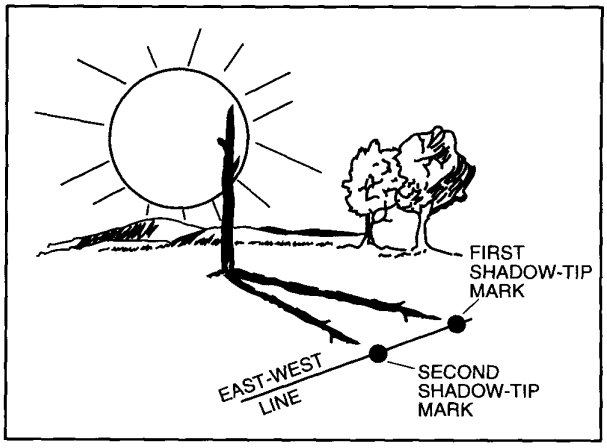


Illustration 2.8.10

4. Determine which is the east end of the line and which is the west end using these tips: (1) the sun rises in the east and sets in the west, (2) the shadow tip moves in the opposite direction, and (3) the first shadow tip mark is always west, and the second mark is always east.

5. To find north and south, draw a line at a right angle to the east-west line at any point (see Illustration 2.8.11). From this north-south line, you can now orient your map and determine the direction you want.

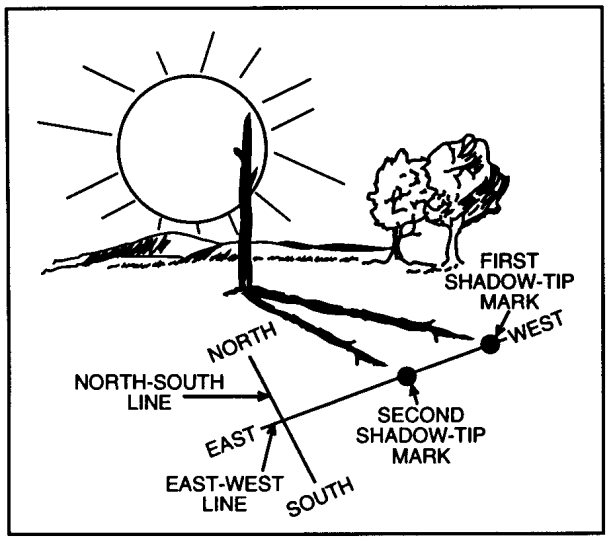


Illustration 2.8.11

WATCH METHOD

You can also use a watch to determine the approximate true north or true south; however, this method can result in errors, especially in the lower latitudes, and may cause circling.

In the *northern hemisphere*, point the hour hand toward the sun. Find a north-south line midway between the hour hand and 12:00 o'clock, standard time. If on daylight saving time, find the line between the hour hand and 1:00 p.m. If you have any doubt as to which end of the line is north, remember that the sun is in the east before noon and is in the west after noon (see #1, Illustration 2.8.12).

In the *southern hemisphere*, point the 12:00 o'clock dial toward the sun, and halfway between 12:00 o'clock and the hour hand will

be a north-south line. If on daylight saving time, the line will lie midway between the hour hand and 1:00 p.m. (see #2, Illustration 2.8.12).

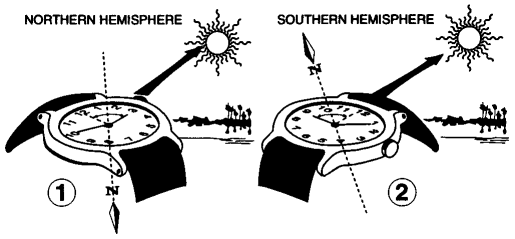


Illustration 2.8.12

GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a high-tech worldwide radio-navigation system formed from a network of 24 satellites and their ground stations. GPS is the first system to pinpoint such a precise location for any point on the globe, during any kind of weather. This system utilizes these satellites to calculate positions down to a matter of meters. As a matter of fact, use of advanced forms of GPS can pinpoint locations down to a centimeter. GPS receivers have become more economical and, therefore, accessible in recent times. Uses of the GPS system include: air navigation, mapping, pinpointing locations, and navigating routes for cars and boats.

A GPS receiver uses the travel time of radio signals to measure distance. The satellites are closely monitored so that their exact location is always known. Any delays created by the radio signals traveling through the atmosphere are corrected.

CONCLUSION

In this chapter, we showed you how to determine a point on a map to within 10 meters using an eight digit coordinate; locate an unknown point using intersection, resection, and polar coordinates; and determine direction using two field-expedient methods.

By using these skills in conjunction with the other map reading skills that we have presented in the previous lessons, you should be capable of finding your way regardless of the situation. You may even have the opportunity to test your skills on an orienteering course (as explained in the next chapter) or on another form of a land navigation course.

* * *

ORIENTEERING

LESSON 1: ORIENTEERING

PURPOSE

This lesson will introduce you to orienteering, its techniques and terminology, as well as the various types of orienteering courses. In addition, many of the map reading and land navigation skills practiced in previous lessons will be applied.

Aiming Off
Attack Point
Control Points
Orienteering
Steering Mark

INTRODUCTION

Orienteering began in Scandinavia in the 1800s, primarily as a military event and as part of military training. By 1919 it had became a competitive sport in Sweden. Then in the early 1930s, the sport received a boost with the invention of an improved compass. Bjorn Kjellstrom, one of the inventors of that compass, introduced orienteering to the U. S. in 1946.

Orienteering is for all ages and degrees of fitness and skill. It provides the suspense and excitement of a treasure hunt. The object is to locate **control points** (see Illustration 3.1.1) by using a map and compass to navigate the terrain.

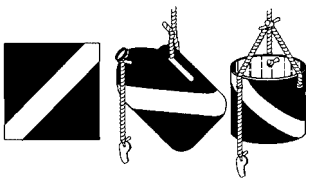


Illustration 3.1.1

Organizers of an orienteering event will give each participant a topographic map with various control points circled. Each control point has a corresponding flag marker on the ground and a special punch which organizers use to mark the scorecard. Competitive orienteering involves running from point to point. It is more demanding than road running, not only because of the terrain, but because the participant must make decisions, and keep track of the distances covered. Courses may be as long as 10 kilometers.

Although orienteering challenges both the mind and the body, the competitor's ability to think under pressure and make wise decisions is sometimes more important than speed or endurance. The person just starting out in orienteering should concentrate more on refining map reading and land navigation skills than on running between the control points.

TYPES OF ORIENTEERING COURSES

There are different types of orienteering events that range from individual courses, to a relay event, to night competition. All types of orienteering courses are interesting and challenging, but they vary in their degree of difficulty. The best location for an orienteering course is one that is easily identifiable on both a map and the actual terrain. It should also be accessible from several routes. Listed below are some of the most common orienteering events/ courses.

ROUTE ORIENTEERING

This form of orienteering can be used by beginners to the sport as well as for advanced competition. In route orienteering, a master (or advanced competitor) walks a route while beginners trace the actual route walked

on the ground using their maps. Beginners circle the location of the different control points found along the walked route. When they finish, organizers analyze and compare the maps. For beginners, time is not a factor in this event.

Another variation of route orienteering involves a course laid out with markers for the competitor to follow. Because the route is indicated with flags or markers, there is no master map. The winner of the event is the competitor who successfully traces the route and accurately plots the most control points.

LINE ORIENTEERING

In line orienteering, competitors trace on their maps a pre-selected route from a master map that has at least five control points. The object is to walk the route shown on the map, circling the control points on the map as competitors locate them on the ground. See Illustration 3.1.2.

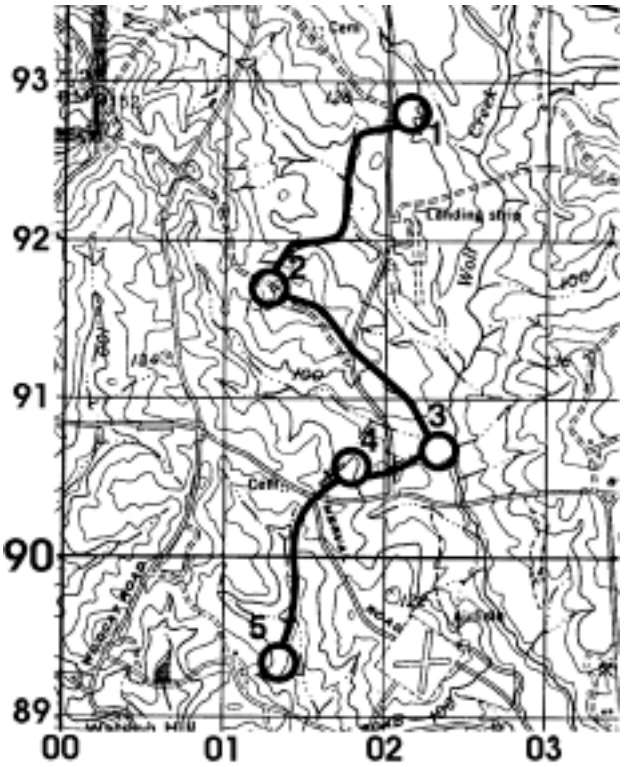
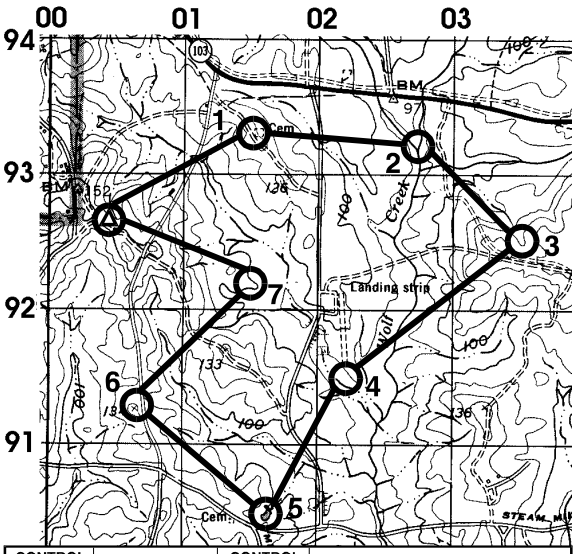


Illustration 3.1.2

CROSS-COUNTRY ORIENTEERING

Cross-country (or free-point orienteering) is the most common type of orienteering competition. It is considered to be the most competitive and intriguing form of orienteering. In this event, all competitors must visit the same control points in the same order. With the normal one-minute starting interval, it becomes a contest of route choice and physical skill. The competitor with the fastest time is the winner.

The length and difficulty of the course is determined by the skill of the competitors. There are usually six to 12 control markers on the course in varying degrees of difficulty and distances apart so that there are no easy, direct routes. The course may be closed-in with the start and finish located at the same position (see Illustration 3.1.3) or the start and finish may be at different locations.



CONTROL NO.	COORDINATES	CONTROL CODE	DESCRIPTION OF CLUES
1	GL01589334	WE	CEMETARY, NORTHERN PART
2	GL02709323	WT	CREEK JUNCTION-CENTER
3	GL03509250	DA	DRAW,CENTER
4	GL02229150	WK	SOUTH END OF RUNWAY
5	GL01709050	CM	EAST END OF POND
6	GL00659125	RD	HILLTOP 134-TOP
7	GL01509218	JD	SPUR-150 SOUTHEAST OF HILLTOP

Illustration 3.1.3

Organizers mark each point in order on a master map. They give competitors a clue list that describes each control point with an 8-digit grid coordinate, a two-letter control code, and a clue describing the terrain in the location of the marker. Competitors must indicate on their score cards proof of visiting each control marker. This is usually done with a special stamp or punch.

SCORE ORIENTEERING

In this event, the area chosen for the competition has many control points. The control points near the start/finish point (usually identical in this event) have a low point value, while those more distant or more difficult to locate have a high point value. The competitor must locate as many control markers as possible within the specified time (usually 90 minutes).

As with a cross-country event, organizers give each competitor a map and an event card. The card lists all the control points with their different values.

Organizers design the course (see Illustration 3.1.4) so that there are more control points than a competitor can possibly visit in the allotted time. Therefore, competitors must plan and choose their route between control points carefully. Points are awarded for each control point visited and deducted for exceeding the specified time. However, there is no reward for returning early with time still available to find more points. Therefore, the good competitor must be able to coordinate time and distance with the ability to land navigate while running the course. The competitor with the highest point score is the winner.

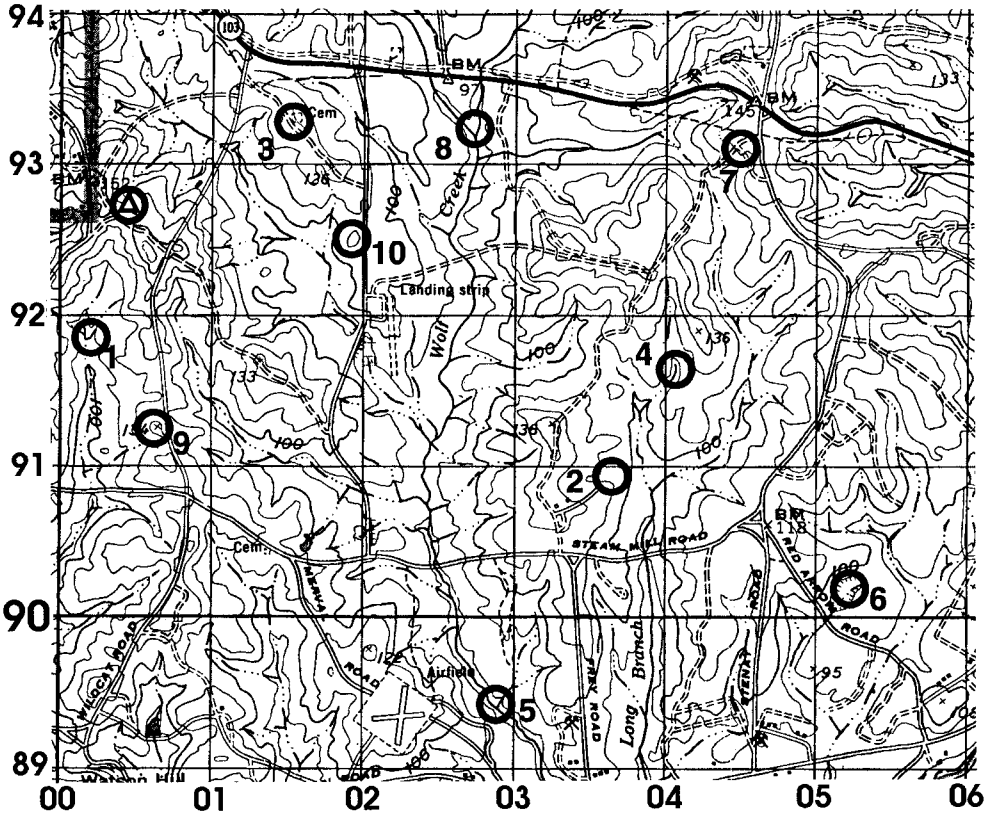


Illustration 3.1.4

RELAY ORIENTEERING

This type of orienteering is a popular team sport. Each member of the team runs a free-point or line orienteering leg of one to two miles. No person runs more than one leg. The competition may be held using a master map for the entire course or one for each leg.

In the case of a master map for the entire course, the first team member copies down all legs of the course. After completing the first leg, he or she hands the map to the next runner, who completes the next leg of the course. The team repeats this process until all members have run their portion of the course.

In the case of a master map for each leg, the first trainee goes to a master map that has only the first location on it. When that person completes the first leg, he or she gives the map to the next person, who goes to a different master map and copies the second portion of the course. This continues until all members of the team have completed their legs.

NIGHT ORIENTEERING

Night orienteering is a free-point or score event occurring in the evening. The main differences between a night conducted free-point or score and one conducted during the day are:

- Control points are marked by a light that is visible from 30 to 50 meters in all directions.
- Control points are located no more than 400 to 800 meters apart.
- The event is run over less difficult terrain.
- Competitors receive a detailed safety briefing before the event begins.
- The signal used to indicate the conclusion of the event or an emergency is a vehicle horn or a flare.

CONTROLLING YOUR MOVEMENT

DETERMINING DIRECTION OF TRAVEL

Once you have plotted the course's control points, you must determine how to get to the first and other control points. The basic compass technique used in orienteering to determine direction of travel consists of five steps:

- Step 1. Lay the map on a flat surface and orient it to magnetic north by placing the edge of the compass along a north-south grid line. Rotate the map and compass until the north arrow is under the black hairline.
- Step 2. Keeping the map oriented, move the compass in such a way that one side of the compass touches your location and your destination. The compass is now pointing in the direction of travel.
- Step 3. Rotate the bezel ring until the luminous line is pointing to grid north on the map. The luminous line should be over the north arrow (if the map is still oriented) and it should be parallel to the north-south grid line.
- Step 4. Lift the compass off the map and correct for magnetic declination. If the declination is west, rotate the bezel ring counterclockwise; if east, then rotate it clockwise.
- Step 5. Holding the compass in front of you, rotate your body until the north arrow lies under the luminous line. The direction of travel is now indicated by the black hairline.

ROUTE SELECTION

As mentioned at the beginning of this chapter, orienteering develops many skills besides map reading. An important one is decision-making. Route selection is where competitors must make decisions. Which is the fastest way from point A to point B? Is it over or around a hill? Is it going cross country or using a road or trail? Except for those instances when organizers mark or specify the route in advance, wise route selection is important.

A good orienteering course will have some elevation obstacles. These obstacles will force you to decide if it is faster to go the most direct route over it or to take a longer detour around it. A simple formula to convert height into comparable flat distance is: *25 feet of elevation equals 100 meters on a flat surface*. For example, suppose the straight line distance to point B is 500 meters with a 50 foot high hill en route. The energy you would expend would be equivalent to running 500 meters plus an additional 200 meters for going over the hill. If the detour around the hill equals a total of 680 meters, it may be easier to go around it, depending upon the type of terrain you encounter.

The type of terrain and vegetation that you encounter has a major impact on your pace. You must know your pace count through several types of terrain. In addition, you must know your pace when trotting and running, both when you are fresh and when you are tired. Although pacing will vary from individual to individual, Illustration 3.1.5 may be useful to a beginner. These figures apply during daylight, when the runner is fresh and on flat terrain. The numbers represent paces or each time the left foot strikes the ground.

	SMALL (less than 5'8")	MEDIUM	TALL (over 6' tall)
Road/Path	42	40	47
Light Vegetation	45	43	40
Open Forest	50	46	43
Dense Forest	55	50	46

Illustration 3.1.5

MOVEMENT TECHNIQUES

In addition to knowing where the control points are and where you are at all times, you must also know the best route for getting to the next control point. The shortest route may not be the fastest, and it may not pay to travel between two points as fast as possible if you tire yourself out in the process. Remember, you can locate your position on a map using terrain features, a back azimuth, or resection.

There are several techniques available to aid you in moving from one control point to another. They include the following:

- *Direct line*. This method involves establishing a compass bearing between your location and the destination. Then, follow the compass bearing until you reach the point. A variation of this technique is to establish a compass bearing that you will follow for a specific distance at which time you establish a new bearing. Repeat this process until you reach the final destination.

- ***Steering marks***. A steering mark is a prominent object or terrain feature on the ground that you can see and that is in the general direction of travel. Such objects as a lone tree or building are good examples of steering marks. One of the advantages of this technique is that once you reach the

steering mark, you can reorient yourself before continuing.

- ***Aiming off***. This technique is valuable when your destination lies along a linear terrain feature such as a road or stream. Due to errors in compass or map reading, you may reach a linear feature and not know whether your objective lies to the right or the left. Furthermore, each degree that you are offset to the right or left will move the aim-off point from the destination 17 meters to the right or left for each 100 meters traveled. For example, if the number of degrees offset is 10 and the distance traveled is 100 meters, then your location is 170 meters to the left of the objective (10 degrees offset X 17 meters per 100 meters traveled = 170).

  A proven technique to prevent this from occurring is to deliberately aim to one side of the destination. Then, when you reach the linear feature, you will know in which direction to turn.

- ***Attack points***. When using this technique, you select a prominent terrain feature, such as a hilltop or road junction, near your destination. You may use any technique to arrive at this point. Once there, you can reorient yourself, and then make a final short approach to it. The purpose of this technique is to minimize the distance you have to travel on the final approach. This in turn limits any errors in compass work or pacing you might make in locating the destination. The difference between an attack point and a steering mark is that you select an attack point from a map.

- *Geographic orientation*. This technique involves keeping the map oriented as you travel and remembering what terrain features you will encounter en route to the next control point. For example, if you decide to follow a road to reach the next control point, you should orient the map as you stop and make turns along the road.

  Using Illustration 3.1.6, assume that you wish to travel from your position at "A" to control point 4. One route that you could take would be to use the north-south intermittent stream bed. Pass the first two east-west intermittent stream junctions that you encounter and take the eastern fork at the third junction. Follow that intermittent stream and draw to the road junction (which you can call an attack point). From the road junction, shoot an azimuth of 77 degrees to the control point.

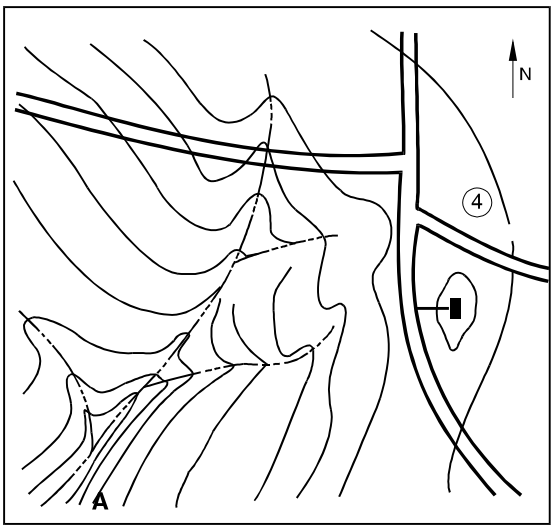


Illustration 3.1.6

CLOTHING AND EQUIPMENT

When planning to participate in an orienteering event, you should wear and take the proper clothing and equipment.

Choose the *clothing* to wear depending on the type of vegetation and terrain you will encounter on the course. For example, in bushy terrain, you should wear a long-sleeve shirt and long pants to protect against cuts and scratches. For those who want to pursue orienteering as a sport, consider purchasing light nylon racing suits. These are full-length suits (usually fluor-

escent) with long sleeves and pouches in the front to carry maps, compasses, etc.

Hiking *shoes* or boots are excellent for orienteering because of their durability and the ankle support they provide. High-top sneakers also provide excellent ankle support. Cross-country running shoes are good because they are lightweight and have better traction in mud, but they do not normally support the ankles.

Although a standard military lensatic compass is very good for orienteering, its one disadvantage is the time required for the needle to stabilize prior to lining up an azimuth. Those who desire to pursue orienteering as a sport may want to acquire an induction dampened or liquid-filled compass.

The *map* is probably the most important item the participant carries. The most common map used in orienteering is a topographic map with a 1:50,000 scale; however, competitors prefer a 1:25,000 scale because it is easier to read and it shows features in greater detail. Try to use multi-colored maps if they are available. Once a competitor outlines the course details and copies the key terrain features from color-coded master maps, his/her own maps, should be covered with a clear, plastic-like material such as a document protector to prevent these marks from smearing and/or becoming unreadable.

ORGANIZATION OF THE COURSE

OFFICIALS

Most events often use the same officials at both the start and finish. They include:

At the Start

- Course Organizer. Briefs competitors in the assembly area, issues event cards and maps, and calls competitors forward to start individually (or in groups if it is a group event).
- Recorder. Records the competitor's name and start time on recorder's sheet, checks the competitor's name and start number on the event card, and issues any last-minute instructions.
- Timer. Controls the master clock and releases the competitors across the start line at their start time (usually at one-minute intervals) to the master map area.

At the Finish

- Timer. Records the finish time of each competitor on his or her event card and passes the card to the recorder.
- Recorder. Records competitor's finish times on the recorder's sheet and tallies final score based on time and correctness of control points visited.
- Course Organizer. Verifies correctness of names, finish times, and final score. Posts competitors' positions on a results board and accounts for all participants at the end of the event.

More officials and/or assistants may be used. However, the three listed above are the minimum required to run the competition.

CONTROL AREAS

In many orienteering events, there are three or four control areas. They are:

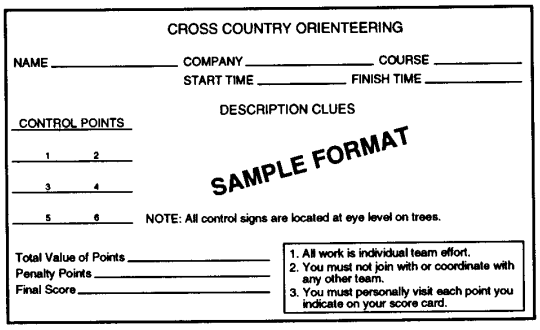
- *Assembly Area*. Here participants register and receive instructions, maps, event cards, and start numbers. They may also change into their orienteering clothes if facilities are available, study their maps, and fill out their event cards. Sanitation facilities are normally available in this area.

- *Start (Start/Finish).* At the start, each competitor reports to the recorder and timer to be logged in and released. Oftentimes, the start and finish are at the same location.

- *Master Map Area*. There are three to five master maps 20 to 50 meters from the start. When the participants arrive at this area, they must mark all the course's control points on their maps. Having done this, competitors must decide on the route they will follow. Experienced competitors will take the time to orient their map and carefully plot the route before rushing off.

CONTROL CARDS

- *Event Card*. Organizers make the event card as small as possible so that competitors can easily carry it in a pocket. It contains the following items: name, start number, start time, finish time, total time, place, and spaces for marking the control points visited. As indicated earlier, it may also contain a listing of descriptive clues. Illustration 3.1.7 is a sample event card for the most common type of an orienteering course.


CROSS COUNTRY ORIENTEERING

NAME _____ COMPANY _____ COURSE _____

START TIME _____ FINISH TIME _____

DESCRIPTION CLUES

CONTROL POINTS

1 2

3 4

5 6

SAMPLE FORMAT

NOTE: All control signs are located at eye level on trees.

Total Value of Points _____

Penalty Points _____

Final Score _____

1. All work is individual team effort.
2. You must not join with or coordinate with any other team.
3. You must personally visit each point you indicate on your score card.

Illustration 3.1.7

- *Clue Description Card*. Organizers prepare these cards with the master maps after the course is set. They contain the descriptive clues for each control point, control code, grid coordinate references, returning time for competitors, removal times for each location, and panic azimuth. Organizers keep the clue description cards and the master maps confidential until the competitors start the event.

SCORING

Organizers score the *cross-country* or *free event* by the competitor's time alone. Competitors must visit all control points; failure to visit one results in a disqualification. In this event, the fastest time wins. A variation that organizers often use for beginners is to have a "not-later-than" return time at the finish and to add minutes on to their final time for the number of minutes late and for the number of control points not located.

The *score* event requires the participant to collect as many points as possible within the time limit. Organizers deduct points for extra time spent on the course — usually one point for every 10 seconds over the time limit.

SAFETY

The following items and provisions are required to ensure that an orienteering course runs as safely as possible. Furthermore, the course organizer will ensure that all participants receive a detailed safety briefing that covers the key information listed below.

- *First Aid*. Ensure that a first aid kit is available at the start and finish. One of the officials should be trained in first aid, or a qualified medical person should be at the event.
- *Control points*. Locate all control points where the safety of the competitors is not endangered by hazardous terrain or other conditions.
- *Safety lane.* Designate a location, usually linear, on the course where competitors may go if injured, fatigued, or lost. A good

course will usually have a well-defined boundary as a safety lane, then competitors can set a panic azimuth on their compass and follow it until they reach the boundary.

- *Finish time.* All orienteering events must have a final return time. At this time, organizers should sound a loud siren or horn and all competitors must report to the finish line, even if they have not completed the course.
- *Search and rescue procedures.* If all competitors have not returned by the end of the competition, the officials should drive along the boundaries of the course to pick up the missing people.

Interest in orienteering within the United States has grown rapidly over the years. Orienteering is conducted under the guidelines of the United States Orienteering Federation, which presently has approximately 70 clubs affiliated with it.

CONCLUSION

Orienteering is a form of land navigation where the terms, symbols, and techniques are different from military land navigation. Although an expert military map reader/land navigator is by no means ready to complete a civilian orienteering event, military experience and training in navigating on the ground and reading maps (as well as physical training and decision-making) will help you to become a good orienteering competitor. Several orienteering practices and a complete familiarization with the map reading skills that we presented in previous lessons will help you to gradually become competitive in this exciting and challenging sport.

AIR NAVIGATION

LESSON 1: GETTING THERE BY AIR

PURPOSE

For centuries, people dreamed of flying like birds. They told stories of flying beings and designed flying contraptions that remained earthbound. In 1903, the Wright brothers made human flight a reality, and today air flight is a common occurrence. Aircraft are used to transport cargo as well as people. We "fly" for recreation as well as business. Travel by air brings almost every part of the world physically within your reach in far less time than travel by car, train, or boat.

This lesson will give you a glimpse into the world of flight by teaching you about air navigation and flight execution. It will boost your map reading skills and point out the differences between getting there on the ground and flying there in the air.

altimeter
cultural features
Greenwich Mean Time
hydrographic features
linear features
nautical mile
pilotage
preflight
prime meridian
statute mile

INTRODUCTION

As you discovered in previous *Map Reading* lessons, when you travel on foot, you have to consider the terrain. Where is the best place to cross a stream? Do you walk over a hill or around it? How long will it take to get there if the ground level keeps rising and falling? Likewise, travel by car depends on the roads leading to your destination, which in turn maneuver around natural and man-made features. Very rarely can you travel in a straight line on the ground from your departure point to your destination.

Air travel, however, is different. Without the limitations of terrain, you determine your heading and fly in a straight line from point A to point B. Of course, as with ground navigation, you must plan your trip carefully; and once in the air, you must follow your route and keep alert. You may be free from terrain difficulties in the sky, but flying comes with its own set of rules.

AIR NAVIGATION CHARTS

Assume you live in Alexander City, Alabama, and during spring break you want to attend a race at the Talladega International Speedway in Talladega, Alabama. You have your private pilot's license and an available airplane. Before you can begin planning your trip, you need to find the proper map. The information found on topographic and road maps, such as trail markers, building symbols, highway route numbers, and points of interest, will be of little help when flying at 6,000 feet.

Also, road or topographic maps do not depict information about radio aids and tall towers. You need a map designed for air navigation, specifically an aeronautical chart that will show landmarks to aid you in navigating to Talladega.

DID YOU KNOW?

You may use the words "chart" and "map" interchangeably, but most professional navigators refer to maps as charts.

CHART SCALES

Not all aeronautical charts are the same. The pilot of a light aircraft flies low enough to navigate by landmarks identifiable from the air. An airline pilot, however, is only near enough to the ground to navigate by landmarks on take-offs and landings. Therefore, the light plane pilot and the airline pilot need to use different charts with different scales.

Remember, when it comes to charts, covering a large area means using a small scale, while covering a small area means using a large scale. Since you are flying within the state of Alabama, you will use a large scale chart that shows more detail of a small area. An airline pilot crossing the U.S. would use a small scale chart covering a large area.

As discussed in previous *Map Reading* lessons, the scale of a chart may be given as a representative fraction. For example, 1:500,000 indicates that one unit on a chart equals 500,000 units of the same measure on the ground. The most common unit of measure for distance in air navigation is the **nautical mile**.

To understand the size of a nautical mile, recall that you can divide each degree of latitude and longitude into 60 minutes. A nautical mile is one minute of latitude or approximately 6,080 feet — slightly larger than the **statute mile** used in road travel in the U.S., which is 5,280 feet. Since a nautical mile is one minute of latitude, there are an even 60 nautical miles in one degree of latitude. This makes navigating long distances with the nautical mile easier than with the statute mile.

JET NAVIGATION (JN) CHART

The JN has a scale of 1:2,000,000 or one inch to 27.4 nautical miles. Pilots flying long-range, high-speed aircraft use the JN which details **hydrographic** and **cultural features** identifiable from high altitudes.

OPERATIONAL NAVIGATION CHART (ONC)

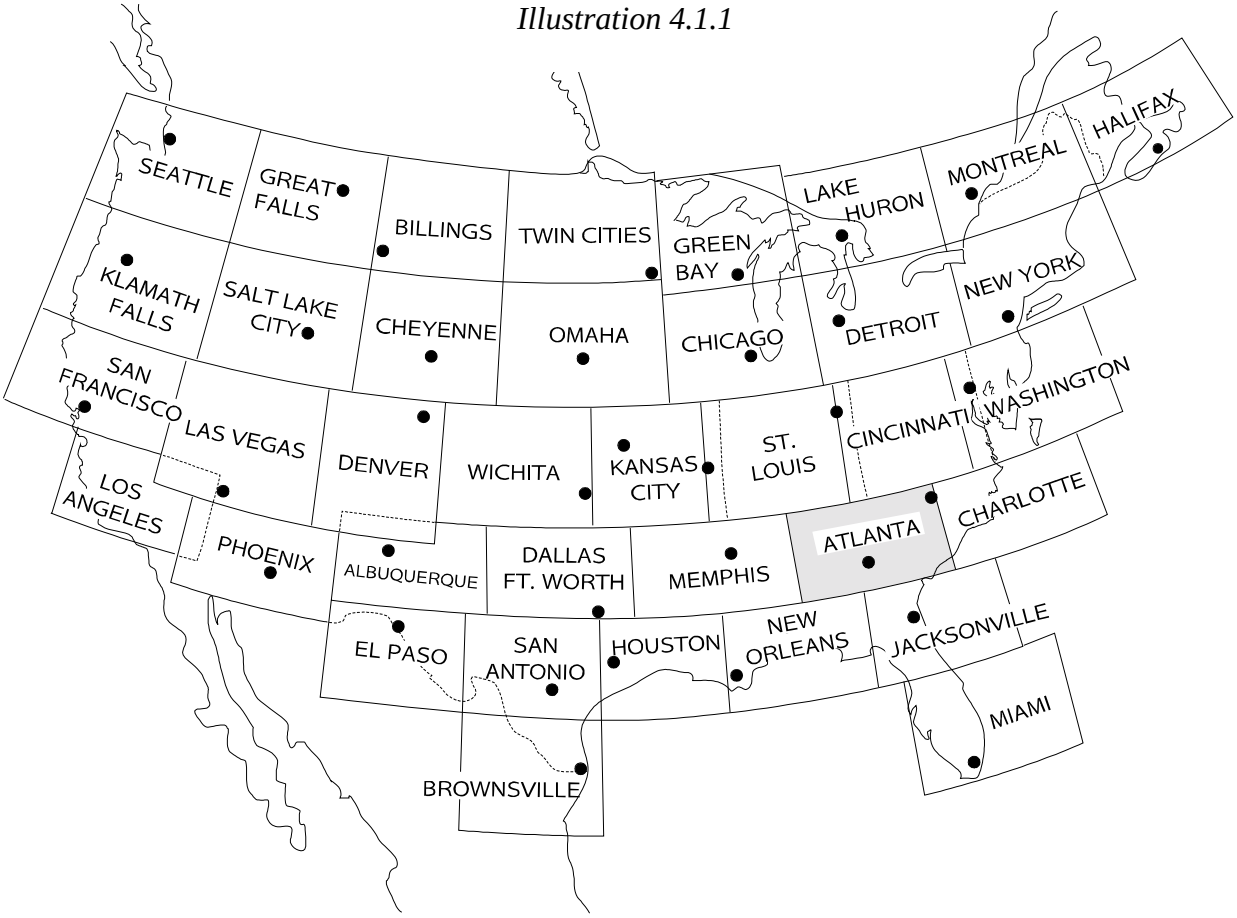
The ONC has a scale of 1:1,000,000 or one inch to 13.7 nautical miles. Since it covers less area on a single chart than the JN, it shows more detail of hydrographic and cultural features. Pilots flying higher-speed aircraft use the ONC for medium- and some low-level navigation.

SECTIONAL AERONAUTICAL CHART

The sectional aeronautical chart has a scale of 1:500,000. It is the largest scale of the three charts discussed here, and therefore shows even more detail of hydrographic and cultural features. It provides excellent ground details for visual ground-chart orientation and depicts navigation aids and air facilities. The sectional aeronautical chart is the basic aeronautical chart of the U.S., and because of its scale and detail, is the chart you choose for your flight.

Since sectional aeronautical charts cover small areas, there are 37 that make up the continental U.S. You must choose which one to use. In the following illustration, you can see that the Atlanta Sectional covers Alabama and

Illustration 4.1.1



is the appropriate chart for your trip. It gives enough details of the ground for you to navigate using visual landmarks from Alexander City to Talladega. This type of landmark flying, called **pilotage,** is the basic method of light plane navigation in good weather.

PREFLIGHT

There are several responsibilities to tend to before any flight. Since these occur before your actual flight, they are generally referred to as **preflight**. As with any hike or road trip you undertake, how well you plan, or preflight, will directly affect how successful and enjoyable your flight is. Preflight activities include:

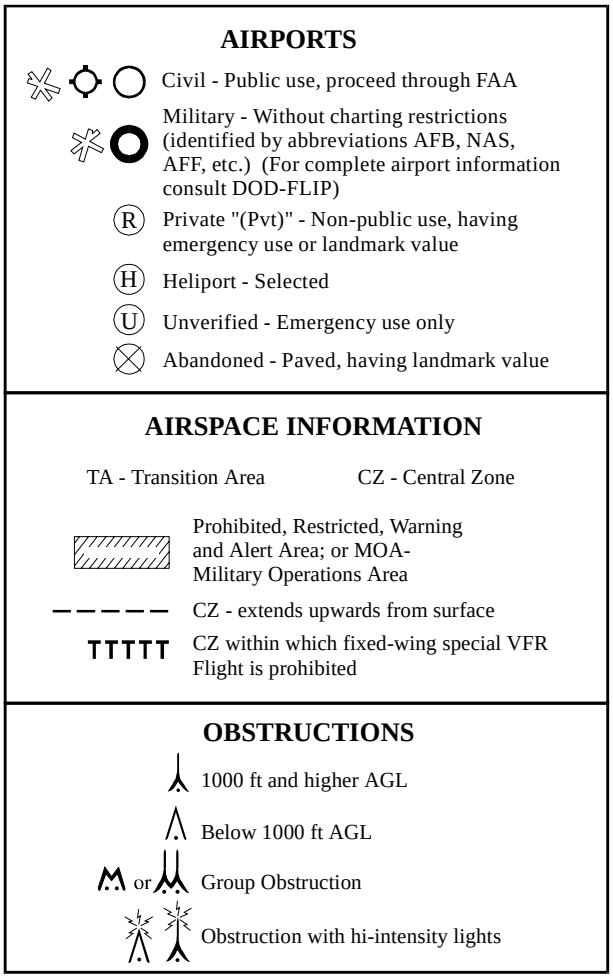
- choosing and studying the appropriate charts
- planning your flight route
- checking the weather
- checking the aircraft
- filing a flight plan.

STUDYING THE APPROPRIATE CHARTS

As discussed in previous *Map Reading* lessons, around the edge of a map are marginal (title) information, relief data, and other symbols that make up the legend. This is also true of aeronautical charts. Check the title information on your chart first, noting that you have the right sectional and, most importantly, that the chart is not obsolete. Never use an obsolete chart for flying! Running into a new tower not plotted on an old chart can ruin a trip.

Next, familiarize yourself with the aeronautical symbols used on the chart. In the illustration below, note the examples of symbols you may not find on a topographic or road map.

Illustration 4.1.2



Read the list of prohibited, restricted, warning, and alert areas included on your chart. This list explains restrictions that apply to designated areas and who is responsible for the areas. For example, altitude is restricted to 5,000 feet over Anniston Army Depot, Alabama, from 0700 to 1800 Monday through Friday under the authority of the CO, Anniston Army Depot. If your flight path crosses any of those areas, make note of what altitude to maintain, adjust your flight path to avoid the areas, or contact the appropriate authority for permission to fly over.

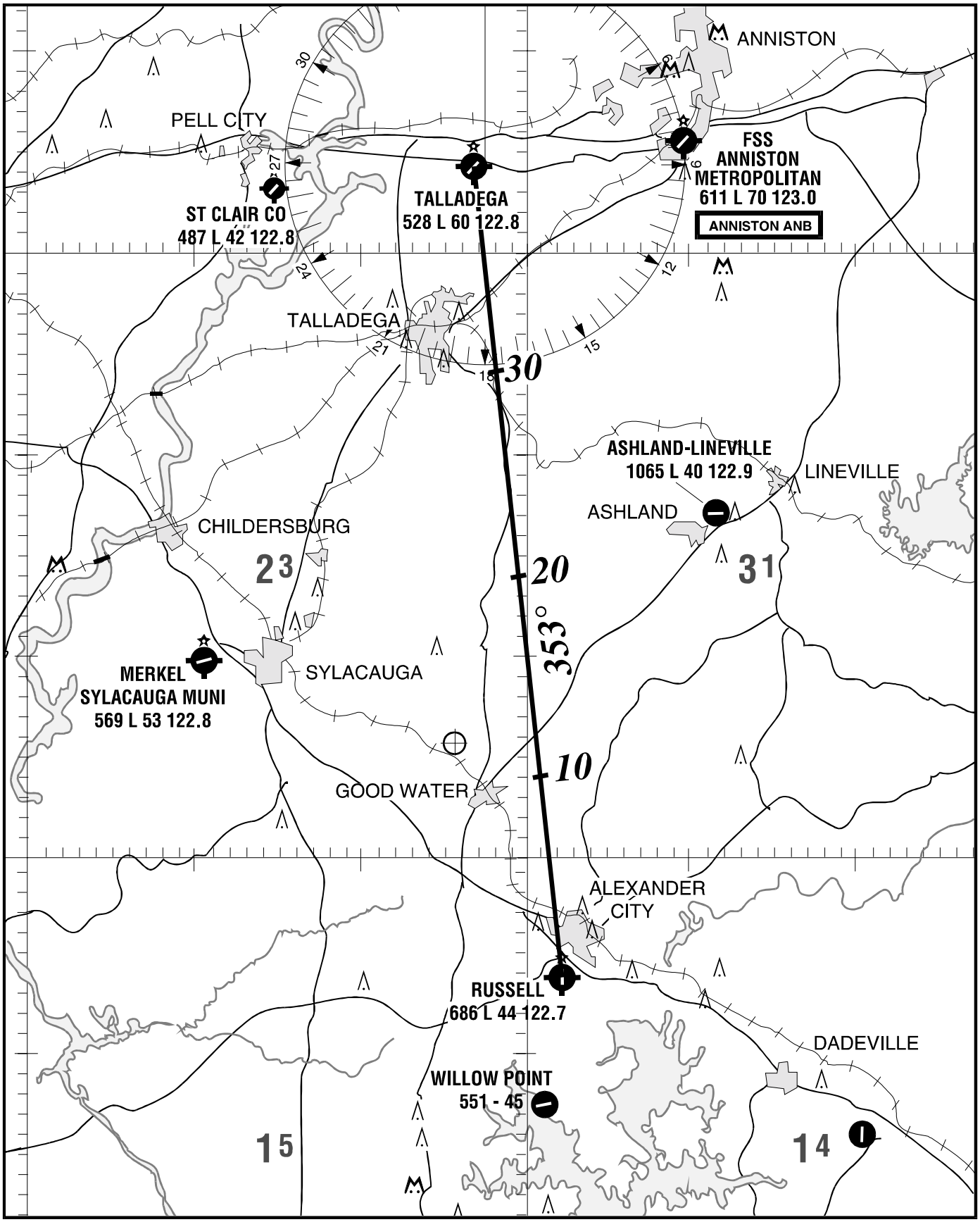
Finally, familiarize yourself with other pertinent information on the chart, such as radio frequencies along your route of flight.

PLANNING YOUR FLIGHT ROUTE

As you learned previously in *Map Reading*, planning a route includes the four elements of navigation: position, direction, distance, and time. Refer to the illustration of the appropriate part of the Atlanta Sectional Chart on the next page as you read about planning your route.

1. Position is a point that you can identify. In this case, you locate the positions of your departure and destination points, specifically Russell Airfield outside Alexander City and Talladega Airport north of Talladega.

Illustration 4.1.3



2. Direction is the position of one point in relation to another without reference to the distance in between them. On your chart, you draw a line between Russell Field and Talladega Airport, then figure direction using an air navigation plotter (below). The plotter consists of a protractor with direction scales and a straight edge. Using this tool, you figure your course from Russell Field to Talladega Airport is 353 degrees.

3. Distance is the space between two points measured by the length of the line joining them. You determine distance for your flight by using the scales on the air navigation plotter, or, as you did in previous *Map Reading* lessons, using the graphic or bar scales on your chart. If using the chart scale, you note ten-mile increments from the scale on a piece of paper. Then place the paper along your route. Transfer the ten-mile increments to your chart marking each increment with the mileage. Your straight-line distance is 40 miles.

4. Time is an elapsed interval. Your aircraft cruises at 120 mph or 2 miles per minute. To determine your flight time enroute, divide 40 miles by 2 miles per minute and you get 20 minutes. Add a few minutes for climbing and reaching cruising speed, and your flight time from Russell Field to Talladega Airport is about 25 minutes.

As you plan your route, familiarize yourself with the locations of other airports or airfields in case you need to make an emergency landing. Look for alternate routes. Identify **linear features** that you can follow. Pinpoint landmarks along your route against which you can cross-check your position.

CHECKING THE WEATHER

After planning your flight route, call the Federal Aviation Administration (FAA) Flight Service Station (FSS) or the National Weather Service (NWS) for a preflight weather briefing tailored to your specific flight. Your local

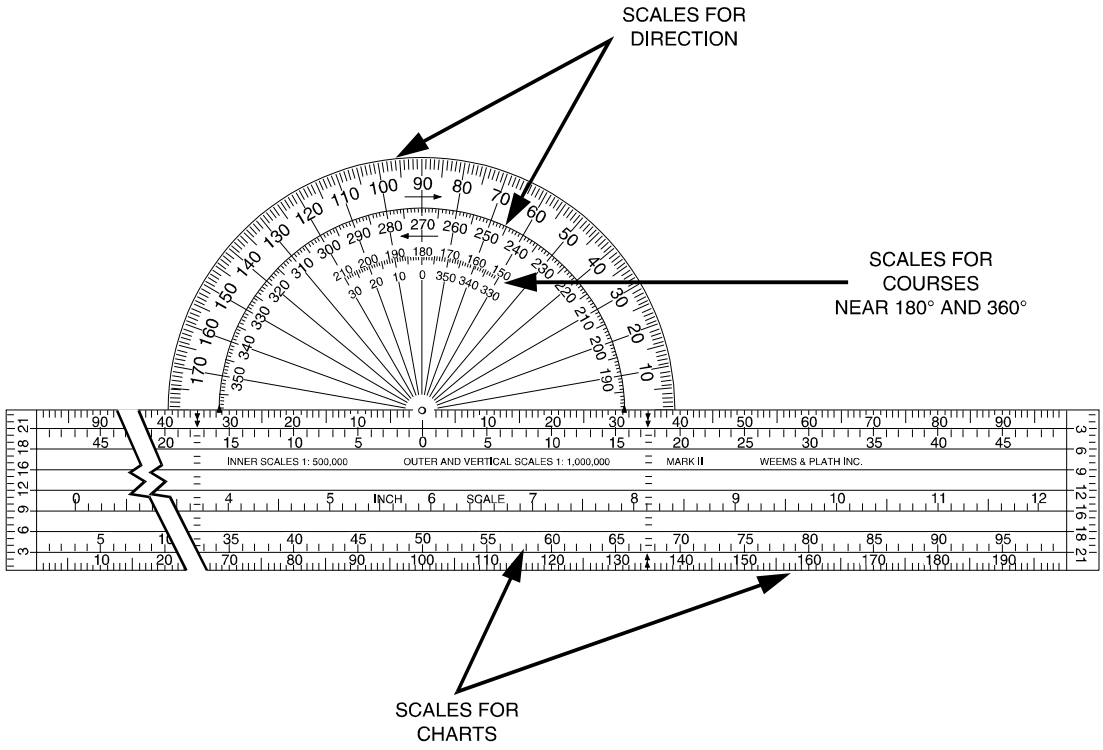


Illustration 4.1.4

phone directory lists FSS and NWS telephone numbers in the U.S. Government section. You will receive current reports and forecasts for departure, enroute, and destination weather, as well as winds at flying altitude and pilot weather reports. For the day you plan to fly to Talladega, you learn that the forecasted weather is good. Winds will be light so they will not affect your flying time.

CHECKING THE AIRCRAFT

You are familiar with your chart, you have studied your route, and you have clear skies. You proceed to your aircraft and perform preflight checks. Everything is in order.

FILING A FLIGHT PLAN

In this scenario, since you are traveling in good visibility, the FAA does not require you to file a flight plan. Understand, however, that the FAA highly recommends a flight plan for all flights regardless of visibility. It lets the proper authorities know your intentions in case of an emergency or if you are overdue at your destination. A flight plan contains your name and address, aircraft description, airspeed, departure and destination points, cruising altitude, and departure and arrival times.

Recording time on your flight plan in this situation is straightforward — you are only flying a short distance north of your present position. However, if you fly far enough east or west of your position, recording time becomes a factor. Unlike ground travel, especially on foot, you travel faster and farther when flying. Therefore crossing time zones becomes a concern.

Before the establishment of time zones in 1883, every city and town had their own time, which led to much confusion. An international convention designated that the **prime meridian**, or 0 degrees longitude, pass through the Royal Observatory at Greenwich, England. This established **Greenwich Mean Time**, the time of day at any given moment in Greenwich, England.

Since the earth rotates 360 degrees in 24 hours, you can divide the equator into 360 degrees or 24 hours. Each hour represents 15 degrees of longitude, and every 15 degrees of longitude, measured from the prime meridian, represents a time zone. Certain populated areas that are divided into two time zones have kept the time of one or the other zone to avoid confusion. You can see this in the illustration of U.S. time zones on the next page.

As a pilot, you have several options when giving your Estimated Time of Arrival (ETA) on a flight plan. For example, if you were to fly from Alabama east into Georgia, intending to arrive at 10 o'clock in the morning your time, you could give 1000 as your ETA and indicate that it is Central Standard Time (CST). Or, since you know that Georgia is in the Eastern Standard Time (EST) zone and it is one hour later there, you could give your ETA as 1100 EST. Another commonly used way to indicate your arrival time would be to use Greenwich Mean Time (GMT) or ZULU time. In this case, you would give your ETA as 1600 GMT or ZULU.

THE FLIGHT

With your preflight complete and your departure time at hand, you takeoff on your flight. As in orienteering, the compass on board your aircraft indicates your direction. Like the speedometer in your car, the airspeed indicator informs you of your speed. Unique to flight, the **altimeter** measures your aircraft's altitude. Throughout your trip, check your instruments to ensure you are on track with your planned direction, speed, and altitude.

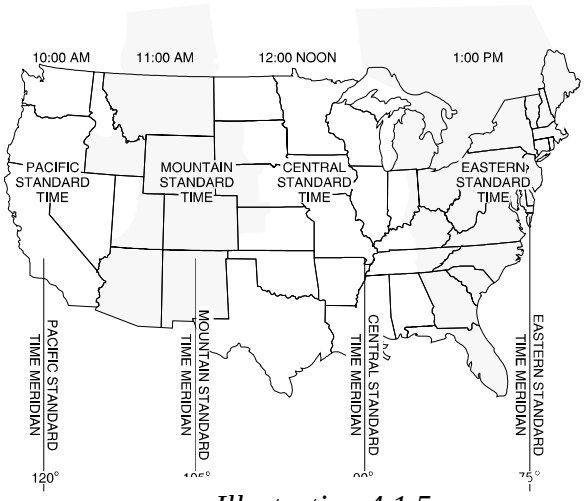


Illustration 4.1.5

The Global Positioning System (GPS) is a high-tech worldwide radio-navigation system formed from a network of 24 satellites and their ground stations. GPS provides precise air navigation and landing systems. This technology makes flying safer, and more efficient. GPS provides the most direct air route for pilots, which saves time and fuel. In addition, the accuracy offered by GPS allows planes to fly closer together on more direct routes. This in turn means that more aircraft can occupy airspace. The benefits of time and fuel efficiency are wide-ranging.

Fly safe. Whether you are hiking, driving, or flying, getting lost or caught in bad weather is no fun and may even put you in an unsafe situation. Proper execution of your predetermined route requires your complete attention, especially when you are in the air. Running out of gas in your car is an inconvenience; running out of fuel in the air can be life threatening. Likewise, traveling at night or in bad weather on the ground requires caution, but you should never fly at night or in bad weather if you are not night-qualified or instrument-certified. If you find yourself running low on fuel, or darkness or bad weather is approaching, do not hesitate to land at the nearest suitable airfield.

Once you learn the basics of pilotage, it is not too complicated to get from here to there in the air. Just pay attention, maintain course and keep track of elapsed time. Along your route, follow the landmarks that you noted on your chart during preflight. Cross-check your position using the features below. First note that you fly directly over Alexander City after takeoff. Since you are flying two miles per minute or ten miles per five minutes, make sure you are on schedule by checking the time against the ten-mile increments marked along your route. For example, within about five minutes into your flight, check that the little town of Good Water is off to your left. Then, as you pass Talladega on your left at the 30-mile marker, check that you are 15 or 20 minutes into your flight. Continue your trip in this fashion, and you will be landing safely as planned.

CONCLUSION

In a plane, you can travel much farther and faster than you can on the ground; and from the air, your perspective broadens as miles of the earth unfold beneath you. This lesson has familiarized you with air navigation charts, preflight, and flight execution. Whether you become a pilot someday or simply travel as an airline passenger, having a basic understanding of air navigation will be helpful in our fast-paced, ever-moving world.

***

EXPLORING THE WORLD

PURPOSE

In today's world, news about places around the globe comes into your home daily through television, radio, newspaper, and the Internet. Much of this news has political, economic, and social implications for the U.S. In order to better understand these events, their origin and their importance, you must learn more about the location of each event. Studying the characteristics of those places, including both their physical and human aspects, will greatly enhance your insight into these events.

This chapter will provide you with a basic overview of world geography from important physical features, natural resources, and climates to political boundaries and other human characteristics that make up the world's diverse landscape. Knowing where places are in relation to each other as well as their differences and similarities will furnish the background information you need to interpret world events. To be an informed citizen of a leading world power and a knowledgeable participant in our global environment, you must possess a broad understanding of the physical world and its human dimensions.

LESSON 1: BEFORE YOU GET STARTED — APPROACHES AND BASIC CONCEPTS

automation
Christian
ethnicity
Hinduism
ideological
Islamic
Judaism
per capita
spatial
tectonic plates

INTRODUCTION

Before embarking on your world exploration, this lesson will investigate the subject of geography and approaches to studying different parts of the world. It will explain the approach taken in this text and the basic concepts you should know as you read this chapter.

WHAT IS GEOGRAPHY?

Geography is the study of the Earth and life on it. It brings together both the physical and human dimensions of the planet, combining earth science (studying the physical makeup or landscape of the environment) with social science (studying humans and their activities within the environment). For this reason, geography encompasses a broad range of subjects, and there are many specialties within the field. The four specialties described below pertain to the aspects of geography that will be discussed in later lessons. Taken together, they will provide you with a **spatial**

perspective of how places and people are organized on the Earth, as well as the characteristics of those places and people.

PHYSICAL GEOGRAPHY

Physical geography focuses on terrain features, climate, soil, vegetation, and natural resources like water supplies and mineral deposits. The following are examples of how the information gathered in the study of physical geography can be applied:

⇒ Studying terrain features and determining what forces have created them — for example, mountains and volcanoes created by the movement of **tectonic plates** — can guide predictions on how natural forces will continue to shape the physical landscape in the future.
⇒ Studying the impact that climate has on an area helps explain the way people live in that area — for example, the types of crops grown, houses built, and clothes worn all vary depending upon whether an area is wet or dry, hot or cold, etc.
⇒ Studying the type of soil, vegetation, and natural resources in an area helps explain the way people make a living there. Economies and standards of living in many areas depend in part on what is supplied naturally to the people in an area — such as rivers to transport goods, coastlines for fishing, and rich soil for agriculture.
⇒ Studying the makeup and importance of natural habitats can be used environmentally to understand the effects of and try to minimize human impacts on those habitats.

CULTURAL GEOGRAPHY

Cultural geography focuses on the characteristics of different groups of people, their distribution throughout the world, their relationship to each other, and the historical developments that resulted in their characteristics and distribution. Understanding the influences of human characteristics, such as culture, language, religion, **ethnicity**, political beliefs, and standards of living, can provide insight into the way different groups of people dress, eat, work, form relationships, support political leaders and governments, treat their environment and other people, etc.

The following two examples demonstrate how religion can impact daily life and certain situations.

⇒ Many businesses close on the day of worship associated with the predominant religion of the region — such as Sunday in **Christian** areas and Friday in **Islamic** areas. Knowing this type of information is important when traveling or doing business in different parts of the world. Will a bank be open when you need to exchange money? If you need to call a branch of a company in another country, what days should you call?
⇒ Islam and **Judaism** forbid eating pork. Therefore, in many predominantly Islamic or Jewish areas of the world, pork is not consumed. **Hinduism** forbids killing cows, which are considered sacred; therefore, in predominantly Hindu areas, beef is not consumed. When marketing internationally, a U.S. company that produces pork or beef products would need to know about these religious beliefs and the locations of these religious groups around the world.

Studying the cultural geography of an area can also provide background into why conflicts occur in different parts of the world. Many conflicts arise from ethnic, **ideological**, and religious differences between distinct groups within a country or in bordering countries. Knowing the location and population of the different groups within a region and their level of toleration for each other can aid in

understanding trouble spots around the world. Perhaps, too, is knowledge can help predict and even prevent conflicts.

ECONOMIC GEOGRAPHY

Economic geography focuses on how people make a living in different parts of the world and the distribution of types of economic activities throughout the world. Types of economic activities include agriculture (raising crops and livestock), mining, lumbering, fishing, manufacturing (processing raw materials into machinery, vehicles, chemicals, textiles, paper products, food products, etc.), services (activities that do not produce a product but provide a service like banking, retail, education, tourism, etc.), and high-technology industries involved in information collection and processing (like computer and software development, telecommunications, simulation, and **automation**).

Studying the economic activities of an area can explain its wealth and the standard of living of its people. For example, an area that grows a crop and also has the capability to manufacture it into a food product for export will generally be wealthier than an area without manufacturing capability for its raw materials. In general, areas involved in technologically-advanced industries are the wealthiest, while areas in which people rely on subsistence farming (growing the minimum required to keep a group or family alive) are the poorest. Understanding the economies of different parts of the world is important in dealing with and trying to lessen economic inequalities. It is also important as investments in businesses and trade relationships are made worldwide.

POLITICAL GEOGRAPHY

Political geography focuses on the political behavior of countries. It examines boundaries established by countries on land, claims by countries to parts of the oceans, relationships between different countries, differences in the government and administration of countries, and the causes of countries remaining intact or dissolving. Having a basic understanding of political geography is important as these countries conduct foreign relations and involve themselves in situations around the globe.

WHAT IS A REGION?

When studying geography, the Earth is often separated into regions. Regions are places grouped together because they possess one or more common characteristics. As with the various geographic specialties, characteristics used to categorize places into regions are physical (location, landscape, climate, etc.) and human (cultural, economic, political, etc.).

Depending upon the characteristic, a place can belong to many regions. Venezuela, for example, is considered *South American* (located on the continent of South America), *Caribbean* (having a coastline on the Caribbean Sea), *Latin American* (people from Middle and South America comprised of people whose native speech is of the Romance languages — French, Portuguese, and Spanish), and *developing* (characterized by low **per capita** income and less technological development due to social and economic conditions). Even Venezuela itself can be considered a region, since its boundaries enclose a specific political area.

Often, geography is discussed in terms of countries or continents, since they are familiar concepts. This text follows that pattern. In each of the following six lessons, a different continent is investigated. (**Note**: Antarctica is examined at the end of this lesson.) Each lesson explores important physical terrain features for the continent and shows political boundaries of the countries within the continent. Cultural, economic and, in

some cases, further physical information is provided for each country or for groups of countries considered regions within the continent.

Remember that geography is a way of organizing information spatially, so that you can picture physical locations and relate the distribution of certain characteristics across those locations. Therefore, as you read through the text, note similar characteristics between countries or areas on different continents. Then visualize a world map with areas containing a specific characteristic: where are the mountainous regions on Earth . . . desert regions . . . English-speaking areas . . . Islamic areas . . . underdeveloped areas, etc.? While the text takes the continent/country approach, it also provides you with information to put in global perspective the distribution of many other physical and human characteristics around the world. The next section provides an example of associating a physical characteristic (different climates) spatially across all continents.

BASIC CONCEPTS

Illustration 5.1.1 shows the locations of the continents (minus Antarctica) and the oceans of the world. Everything above the Equator (0° latitude) lies in the Northern Hemisphere, and everything below it lies in the Southern Hemisphere. Everything to the right of the Prime Meridian (0° longitude) lies in the Eastern Hemisphere, and everything to the left of it lies in the Western Hemisphere.

The Tropics of Cancer and Capricorn parallel the Equator at about 23.5° north and south, respectively. The Tropic of Cancer marks the farthest point north at which the sun can be seen directly overhead at noon. The sun reaches its vertical position over this tropic on about June 21. This means that on that day, the Tropic of Cancer is the latitude closest to the sun. The Tropic of Capricorn marks the farthest point south that the sun can be seen directly overhead at noon. The sun reaches its vertical position over this tropic on about December 21. This means that on that day, the Tropic of Capricorn is the latitude closest to the sun.

For this reason, seasons in the Northern Hemisphere are opposite the seasons in the Southern Hemisphere. While people living north of the Equator are experiencing summer weather from June to September, people living south of the Equator are experiencing winter weather. Likewise, the Northern Hemisphere's winter runs from December to March, during the Southern Hemisphere's summer.

The Arctic Circle (about 66° N latitude) and the Antarctic Circle (about 66° S latitude) are centered on the North and South Poles, respectively. They mark the northern and southern regions in which there is at least one day when the sun never sets and one day when it never rises. For example, when the sun is overhead at the Tropic of Cancer, the North Pole is tilted toward the sun, and the Arctic Circle experiences 24 hours of daylight. The Antarctic Circle, however, experiences 24 hours of darkness because the South Pole is tilted away from the sun. The opposite occurs when the sun is overhead at the Tropic of Capricorn, with the Arctic Circle in darkness for 24 hours and the Antarctic Circle in sunlight for 24 hours.

The details of this discussion have been offered as an accurate explanation for why latitudes have such importance. However, the

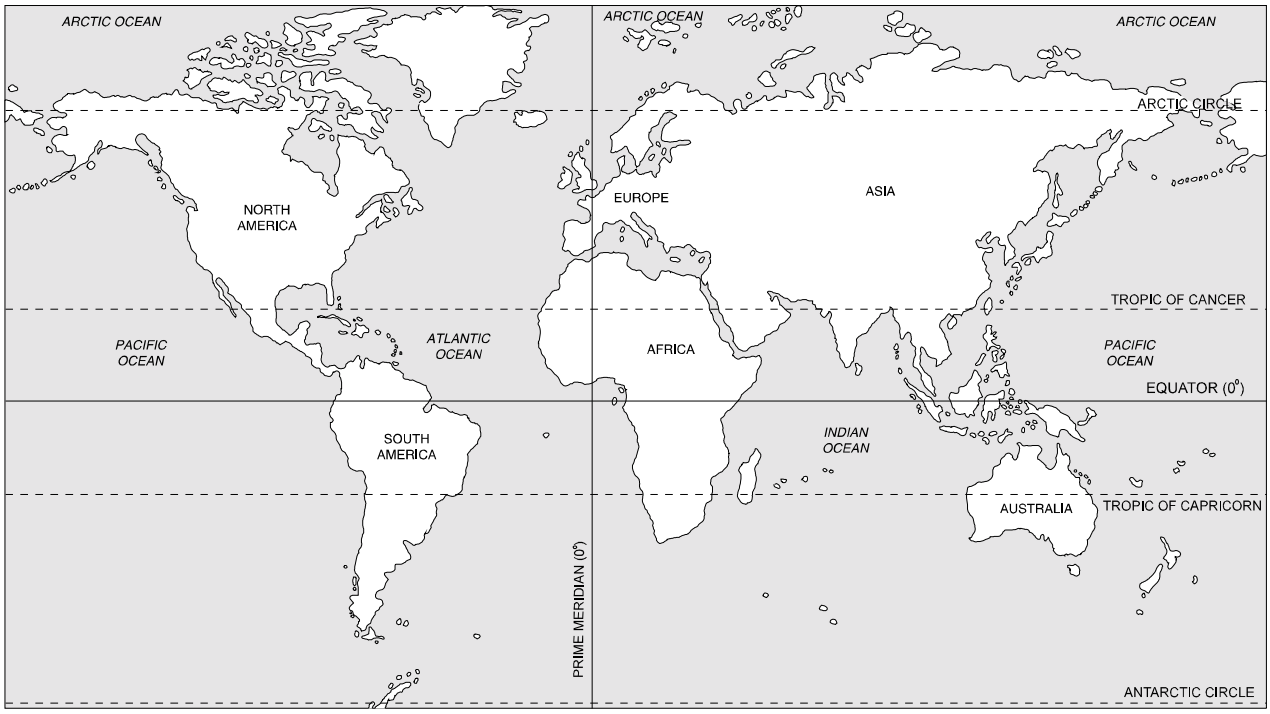


Illustration 5.1.1 — World Map

basic concepts that you should understand from this discussion are that the areas of the Earth between the Tropics of Cancer and Capricorn are closest to the sun. Conversely the areas of the Earth inside the Arctic and Antarctic Circles are the most distant from the sun.

CLIMATE

Several factors affect climate; among them are elevation and proximity to large bodies of water. Yet the most important factor is exposure to the sun, or solar radiation, which, as demonstrated in the previous discussion, is determined by latitude. The Equator at 0° latitude receives the most solar radiation, while the poles at 90° North and South latitude receive the least. Using the Equator, Tropics of Cancer and Capricorn, and the Arctic and Antarctic Circles as guides is a good way to develop a general perspective of basic world climates and the vegetation that grows naturally in an area due to climate.

Between the Tropics of Cancer and Capricorn, tropical climates exist, characterized by hot temperatures throughout the year. Areas along the Equator get plenty of rain all year and the corresponding vegetation is tropical forest (jungle and rain forest). Moving away from the Equator are drought-resistant, tropical grasslands (savanna), particularly in South America, Africa, and Australia, with distinct wet and dry seasons. Moving still farther from the Equator to areas crossed by the Tropics of Cancer and Capricorn are deserts and semi-deserts that get little or no rainfall. Exceptions include each continent's eastern coasts, which continue to get regular rainfall and have more tropical vegetation.

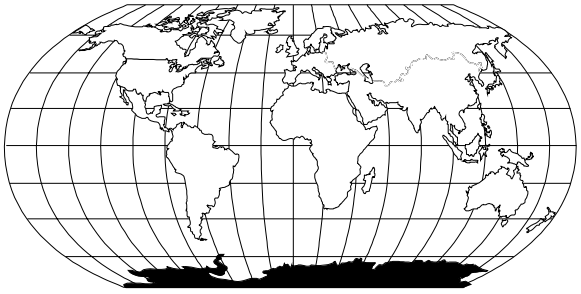
Between the Tropic of Cancer and the Arctic Circle as well as between the Tropic of Capricorn and the Antarctic Circle are areas of temperate (moderate) climate that have four seasons. Of course, areas located closer to the Arctic and Antarctic Circles have cooler summers and colder winters than most areas located closer to the tropics. Within this

temperate zone, much of Asia, Australia, and western North America receives little rainfall, but coastlines, eastern North America, and Europe receive plenty of rainfall. Temperate forests cover much of this area in the Northern Hemisphere, with temperate grasslands (prairies) on the interiors of continents, and deserts and semi-deserts in southwestern Asia and parts of central Asia.

Within the Arctic and Antarctic Circles is a polar climate marked by year-round cold weather and little moisture except in the form of snow. Most of the land is covered by tundra, a treeless, marshy plain of mosses on top of a permanently frozen subsoil. Much of the water is frozen; in fact, the Arctic Ocean, in which the North Pole (Illustration C) is located, is permanently frozen except around its edges.

Generally, people populate areas that have a temperate climate, fertile soil, and adequate rainfall for agriculture. In agreement with the above information concerning world climate, the more populated areas of the planet are southeastern North America, Europe, and south and Southeastern Asia. Desert areas and polar areas have few, if any, inhabitants.

ANTARCTICA



Since this section has already investigated the Antarctic Circle (Illustration 5.1.2), this is an opportune place to discuss the continent of Antarctica, which is located almost entirely within the Antarctic Circle. Antarctica, the fifth largest continent, surrounds the South Pole and is the coldest, iciest piece of land on Earth. During the summer months (November to January) temperatures are usually no warmer than 0°F, and during the winter months (May to July) the average temperature is 270°F. The area is then in continual darkness, and there are dangerous blizzards.

Despite the harsh landscape of the continent, several countries have claimed parts of Antarctica because of its rich supply of natural resources. Minerals and fuels lie beneath its surface, and large schools of fish inhabit its waters. Only Marie Byrd Land remains unclaimed. For now, a 1959 treaty prohibits military activities, nuclear explosions, and disposal of radioactive waste on the continent, and as of 1991, there is a ban on mineral extraction and mining.

CONCLUSION

Geography looks at both the physical and human landscapes of our planet. It encompasses a broad range of topics, including the specialties of physical, cultural, economic, and political geography. The following lessons discuss these four aspects of geography using the familiar concepts of continents and countries as a framework. As similar characteristics between places worldwide are revealed throughout this text, visualize the distribution of those characteristics across the globe. Possessing the skills to organize information in this spatial way and to understand both the physical and human landscapes of our planet is essential to being a geographically informed person in our global environment.

* * *

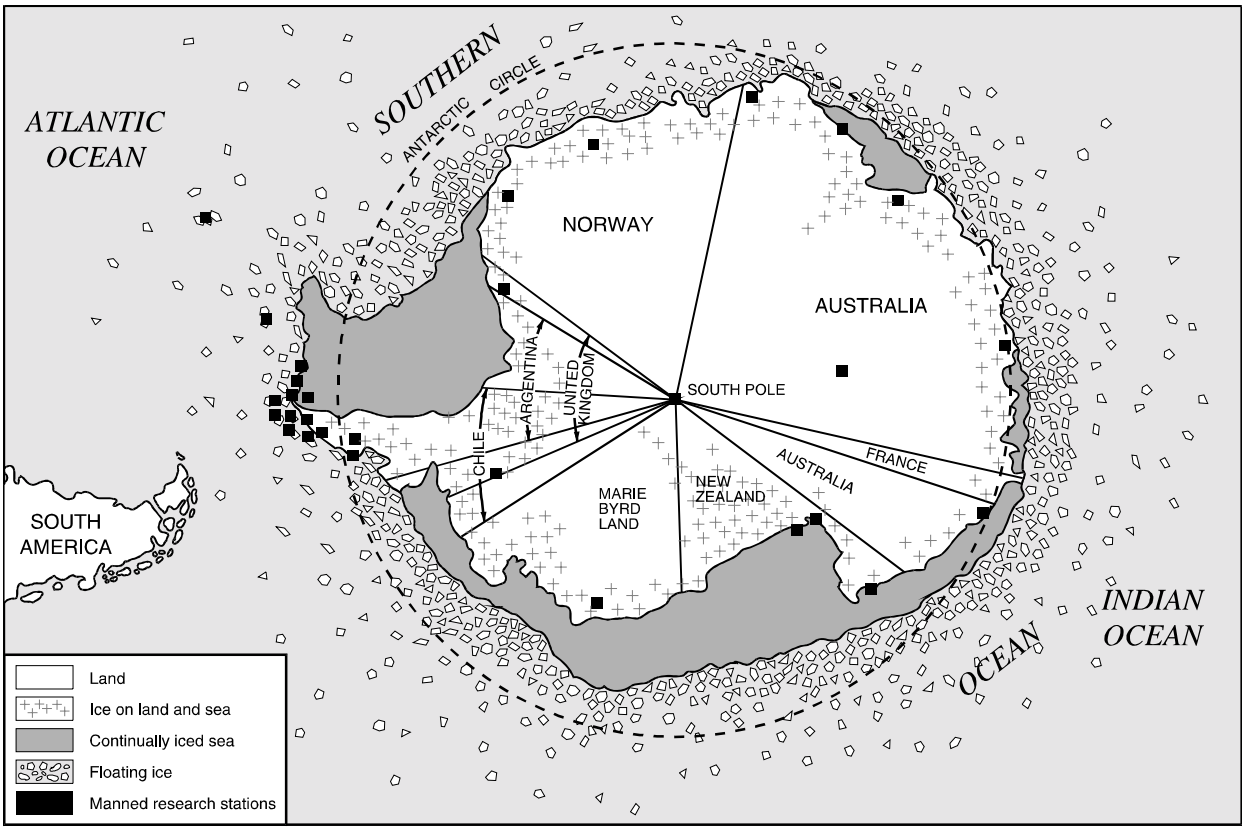
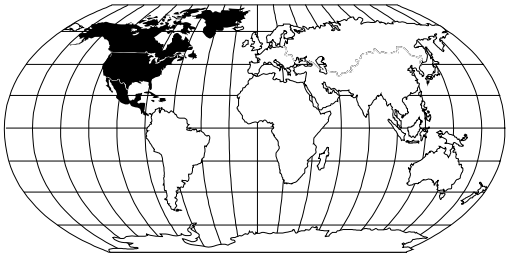


Illustration 5.1.2 — Antarctica

LESSON 2: NORTH AMERICA — FROM TUNDRA TO TROPICS

Catholic
collective
commonwealth
cordillera
dominion
fragmented state
isthmus
plural state
postindustrial
Protestant
semiautonomous

INTRODUCTION



North America (Illustration 5.2.1) is the third largest continent comprising all the land and adjacent islands north of and including the **Isthmus** of Panama. A principal physical feature of North America is the North American **Cordillera**, a mountain region in the west that extends from Alaska to Mexico and includes the Rocky Mountains. Other important physical features are the Appalachian Mountains, the Great Lakes, the Great Plains, and the Mississippi River which, along with the Missouri and Ohio Rivers, makes up one of the world's longest river systems.

The Bering Strait separates Asia in the Eastern Hemisphere from North America in the Western. Many scholars believe that between 7,000 and 20,000 years ago the Bering Strait was a land bridge that allowed people from Asia to migrate to and populate North and South America. These people are the ancestors of today's Native Americans — North American Indians and Eskimos of Greenland, Canada, and the U.S., and Middle American Indians of Middle America. In addition to Native American culture, European and African influences shaped North America as Europeans colonized the continent and brought slave labor from Africa. Over centuries, these cultures combined in a variety of ways to create the human landscape of today's North America.

GREENLAND: THE FROZEN ISLAND

Greenland (Illustration 5.2.1) is the world's second largest island — the largest being Australia. Lying mostly within the Arctic Circle, an ice sheet, which is more than two miles thick in some places, covers over four-fifths of Greenland. Most of the population, however, lives on the island's warmer southwest coast, which is not within the Arctic Circle. A former Danish colony, Greenland is now a **semiautonomous** state of Denmark. About 90 percent of its people are of mixed Eskimo and Danish ancestry.

CANADA: A PLURAL STATE

Canada (Illustration 5.2.2), a self-governing **dominion** within the British **Commonwealth** of Nations, is the second largest country in the world (only Russia is larger). It consists of ten provinces and three territories. Starting in the east are the Atlantic Provinces (Newfoundland, Nova Scotia, Prince Edward Island, and New Brunswick). Moving west, the provinces of Quebec and then Ontario are next. Moving farther west are the Prairie Provinces of Manitoba, Saskatchewan, and Alberta. The westernmost province is British Columbia. In the north are the territories known as the Yukon, Northwest Territories, and Nunavut (created from the eastern half of the Northwest Territories in April 1999).

Illustration 5.2.1

The capital of Canada is Ottawa, located in southeast Ontario. The largest and most populous cities are Montreal, located in Quebec on the Saint Lawrence River, and Toronto, located in Ontario on Lake Ontario. The Great Lakes along with the Saint Lawrence River form a major shipping artery navigable by ocean-going vessels.

The Canadian Shield stretches from the Saint Lawrence River and the Great Lakes northwest to the Arctic Ocean. Formerly referred to as a plateau, it is a region of ancient rock and many lakes formed by the advance and retreat of ice sheets. Centered on the Hudson Bay, the shield covers over half of Canada. The area is rich in minerals and water power.

Southeast of the Canadian Shield in the Atlantic Provinces is the northern section of the Appalachian Mountains which extend down into the southeastern U.S. West of the shield in southwest Manitoba as well as most of Saskatchewan and Alberta are wheat-growing, oil-rich plains or prairies. This area includes the northern reaches of the Great Plains, a semi-arid grassland that extends south into Texas. Along the western border of Alberta and in British Colombia and the Yukon is the North American Cordillera. The cordillera in Canada includes the Rocky Mountains, known as the Canadian Rockies, and the Coast Mountains.

DID YOU KNOW?

The greatest drop between Great Lakes occurs between Lakes Erie and Ontario, falling 167 feet at Niagara Falls.

PEOPLE

Most Canadians possess high living standards and live in an urbanized, **postindustrial** society. The majority of the population is of European descent (approximately 48 percent of British origin and 31 percent of French origin) and of Christian faith (approximately 46 percent are Roman **Catholic** and 45 percent are **Protestant**). In Ontario and the territories are large Indian minorities, and there is a rapidly growing Asian population in the west. Although Canada is a huge country, its population is small — only one-tenth that of the U.S. Moreover, most Canadians live within 100 miles of the U.S. border.

Unlike the U.S., Canada has two official languages. English is the home language to about 62 percent of the population, and French is the home language to 26 percent. Most French-speaking Canadians live in Quebec, where 80 percent of the people are of French origin. Montreal, Quebec, is second only to Paris, France, as the largest French-speaking city in the world.

French-Canadians hold strongly to French history, tradition, and culture, while most other Canadians prefer British customs. This separation of French and British language and culture has inhibited the formation of a single combined culture in Canada and makes Canada a **plural state**.

ECONOMY

Canada's wealth of natural resources makes it a prosperous nation. Forests covering 46 percent of the country support wood-processing industries. Minerals found in the Canadian Shield make Canada one of the world's leading mineral exporters. Coal, oil,

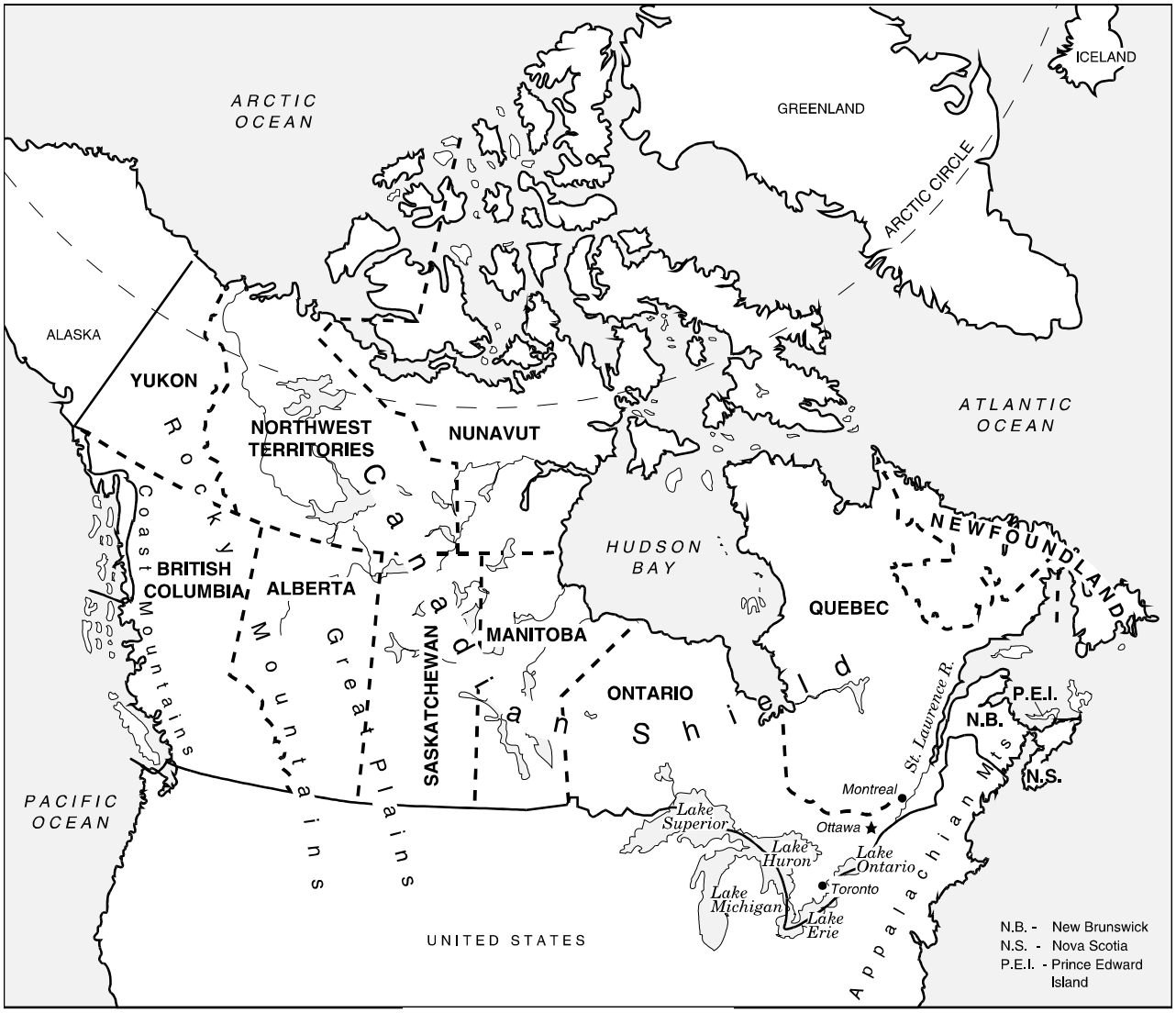


Illustration 5.2.2

and natural gas are abundant in the Prairie Provinces, and agriculture in these provinces produces major exports of grains and meat. The Atlantic Provinces and British Columbia provide most of Canada's fishing catch, and the area's natural beauty attracts many tourists.

Manufacturing is a chief economic activity in Quebec and Ontario. The Great Lakes and Saint Lawrence River form a chief trading artery, with Montreal and Toronto as principal ports. Toronto is also English-speaking Canada's leading financial and communications center. The U.S. is Canada's leading trade partner and an important financial investor.

THE UNITED STATES OF AMERICA: FROM SEA TO SHINING SEA

The United States of America (Illustration 5.2.3), the fourth largest country in the world, includes 50 states and one federal district, the District of Columbia. Canada and the Pacific Ocean separate

Alaska and Hawaii, respectively, from the other 48 states, making the U.S. a **fragmented state**. The U.S. also holds territories in the Caribbean Sea and Pacific Ocean. Because of their geographic locations, these territories and Hawaii, will be discussed later in the sections about Middle America and Oceania.

Like Canada, significant terrain features of the U.S. include the Great Lakes, Great Plains, Appalachians, and the North American Cordillera. The Appalachians run 1,600 miles from eastern Canada to Alabama. East and south of the Appalachians is the Gulf-Atlantic Coastal Plain, characterized by flat, low-lying coastlines in contrast to the mountainous coastlines along the Pacific. Stretching west of the Appalachians are the Interior Plains, fertile lowlands that were once covered by an inland sea. Even farther west are the Great Plains, a treeless plateau area that gradually rises to the foothills of the Rockies.

As mentioned previously, the Rocky Mountains, or Rockies, are part of the North American Cordillera and extend from New Mexico north through the U.S. (Southern, Central, and Northern Rockies) into Canada (Canadian Rockies) and Alaska (Brooks Range). The Cordillera also includes the Alaska Range along the south coast of Alaska, home to Mount McKinley, the highest point in North America. Farther west of the Rockies in the continental U.S., the Cordillera includes the Cascade Range with volcanic peaks like Mount Rainier; the Sierra Nevada; and the Coast Ranges.

Between the Rockies and these western ranges is the Intermontane Region. This region consists of plateaus, basins, and lower ranges. There are also several deserts in this area, one of which is Death Valley in Southern California and Southern Nevada.

Rivers like the Columbia and Colorado have cut deep gorges through the Intermontane Region. One such gorge cut by the Colorado River in Arizona is the Grand Canyon, which is up to 1 mile deep, 4 to 18 miles wide, and more than 200 miles long.

The Continental Divide, which follows the crest of the Rocky Mountains, separates the rivers that drain into the Pacific Ocean from those that drain into the Atlantic. The Columbia and Colorado Rivers flow west from the Rockies supplying power, irrigation, and water to western states. On the other side of the Rockies, the Missouri River flows east then south to meet the Mississippi River near St. Louis, Missouri. Farther south at Cairo, Illinois, the Ohio River meets the Mississippi. These three rivers make up the Mississippi River System, which drains the mid-western U.S. and is the chief river system of North America.

PEOPLE

People of the U.S. have been shaped by the wide variety of immigrant groups who have made the U.S. their home over the past two centuries. Many of the original European settlers came to the "New World" to build better lives based on freedom and equality. Their beliefs became the basis of American social and political life.

Unlike Canadians, people of European descent in the U.S. mixed to form a **collective** group, and immigrants to the U.S. continue to become a part of mainstream American society — thus, the U.S. nickname "the melting pot." In some cases, however, this mixing does not occur. Consequently, immigrants and their descendants find themselves, willingly or not, in ethnic communities inhabited by racial minorities.

Like their Canadian neighbors, Americans enjoy a high standard of living. Both countries are rich in natural resources that contribute to a productive economy. Many Americans relocate as economic opportunities shift from place to place. In fact, Americans are the most mobile people in the world, with 19 percent of the population changing residence each year

REGIONS

The continental U.S. is often divided into the following regions (Illustration 5.2.4) based on physical landscapes, dominant cultures, and/or major economic activities.

New England is famous for its natural harbors, colorful autumns, picturesque villages, and historic sites dating from colonial times. Tourism, recreation, fishing, forestry, and farming in the region's fertile valleys are important economic activities. Manufacturing is a leading source of income in southern New England states, making them part of the Manufacturing Belt as well.

The Manufacturing Belt was the country's economic leader between the Civil War (1861 – 1865) and the decline of the industrial age in the 1970s. Since then, America's economy has turned from traditional manufacturing to high-tech industries. Although manufacturing remains important, fast-growing areas in the west and south provide competition for the Manufacturing Belt. Nevertheless, some cities such as Boston, New York City, and Washington, D.C. are booming in this high-tech age.

The Agricultural Heartland has vast areas of fertile land for crop growth and dairy and livestock production. Iowa and Illinois are the center of the Corn Belt. West of the Corn Belt in the Great Plains is the Wheat Belt. Even the economies of large cities in the region, like Kansas City, Minneapolis, and Denver, are based on agriculture operating major processing centers for grains and livestock.

The South remained isolated economically and culturally from the rest of the country following the Civil War. Then, in the 1960s, interest in the South resurfaced, and it became the United States' most rapidly changing region. With its warm climate and fertile soils, agricultural areas began to produce high-value products like beef, poultry, and soybeans. At the same time, tourists began flocking to the region's coastal beaches. Atlanta, Houston, Miami, Tampa, and New Orleans grew into booming cities practically overnight, and high-tech industries continue to move into the region today.

The Southwest is an area of vast, open space, characterized by long, hot summers. The eastern portion of the region contains abundant supplies of oil and natural gas that provide much of its economic wealth. This region also successfully represents the postindustrial revolution with electronic and space-technology facilities located between Houston (on the dividing line between the South and Southwest regions), San Antonio, and Dallas-Fort Worth.

The Interior Periphery includes Alaska and the area stretching from the Sierra Nevada-Cascade Range to the Rocky Mountains. The region is isolated, rugged, and sparsely populated. Despite its disadvantages, the Interior Periphery is one of the Earth's major storehouses of mineral and energy resources. During the oil shortage of the 1970s, oil companies explored Alaska, Wyoming, and Colorado in search of petroleum and natural gas. Minerals mined in the region include coal, uranium, copper, lead, zinc, platinum, gold, silver, and nickel.

The West Coast covers the area on the Pacific coast between the Sierra Nevada-Cascade Range and the Pacific Ocean. This region, despite being earthquake prone, has a hospitable environment with year-round agreeable weather south of San Francisco.

Major development of the region took place after World War II (1939 – 1945), much of it in California, an innovator of national culture and industry and the most populated state. In Oregon and Washington, long-standing economic activities like logging and fishing still thrive. Industrialization also exists in the form of aluminum and aircraft manufacturing.

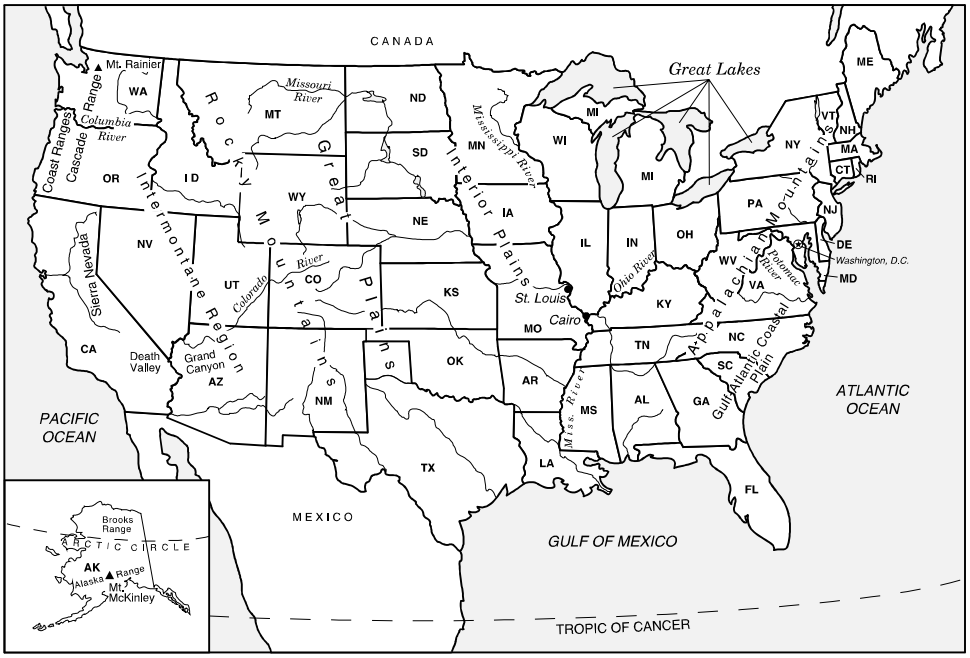


Illustration 5.2.3 — The United States

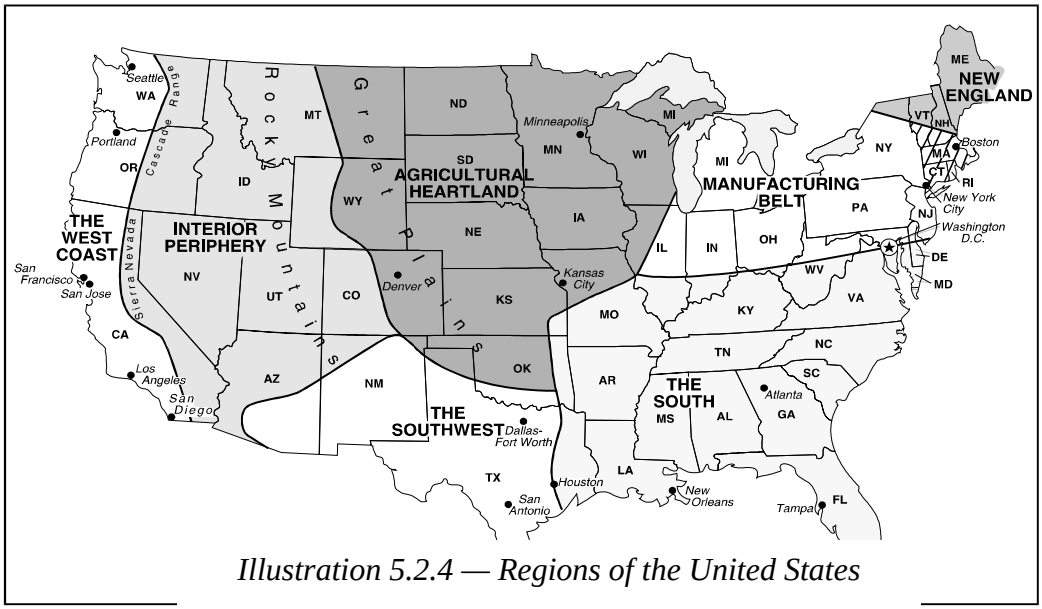


Illustration 5.2.4 — Regions of the United States

Illustration F. Regions of the United States

A great advantage to this region in the current global economy is its proximity to Asia.

MIDDLE AMERICA: SEPARATING ATLANTIC AND PACIFIC

Middle America (Illustration 5.2.1) constitutes all the land and islands south of the U.S. and north of the South American continent. It is a crucial barrier between the Atlantic and Pacific Oceans and a bridge from North America to South America. Middle America consists of:

- Mexico, a large country that dominates Middle America in size, population, and economic wealth
- Central America, consisting of seven countries: Belize, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, and Panama
- The West Indies, which separate into the Bahamas, the Greater Antilles that include the larger islands (Cuba, Hispaniola, Jamaica, and Puerto Rico), and the Lesser Antilles that include all other islands.

A major geographic feature of Middle America is the Sierra Madre Mountain System, which is the southernmost part of the North American Cordillera. This area forms the junction of the North American Cordillera and the outlying reaches of the Andes, a similar cordillera in South America. The area also marks the collision of several tectonic plates. Because of this, Middle America is mostly mountainous, with active volcanoes and earthquakes.

Unfortunately, Middle America is the least developed region in the Americas, and many Middle American people live in poverty. Much of the area is also politically unstable. These two factors drive many Middle Americans to cross the border into the U.S. looking for a better existence.

MEXICO: MERGING CULTURES

Mexico (Illustration 5.2.1) consists of 31 states and the Federal District of Mexico City, its capital. Mexico's significant geographic features include the Baja California Peninsula in the northwest, an extension of California's Coast Ranges; the Gulf of California that separates the Baja California Peninsula from the rest of Mexico. Also noteworthy is the Rio Grande River which separates Texas from Mexico. The Yucatán Peninsula in the southeast and the Sierra Madre Mountain System comprise two other major features of Mexico.

Sierra Madre Del Sur in the south splits as it nears Mexico City, dividing into Sierra Madre Occidental in the west and Sierra Madre Oriental in the east. These mountains frame Mexico's central plateau, which is 8,000 feet in elevation in the south near Mexico City and declines to 3,600 feet at the Rio Grande. The plateau is desert in the north, contains shallow lakes and swamps in the center, and has tropical forests in the south. Generally, Mexico has a dry climate with only 12 percent of the country receiving adequate rainfall.

Important Historical/Political Considerations

Mexico was the birthplace of several great Indian civilizations, including the Maya and Aztec. In the 1500s, Spanish conquistadors conquered the Indians and made Mexico a Spanish colony. Indians became laborers for the Spanish, and a mestizo class (of mixed Spanish and Indian blood) developed. Colonists gained independence from Spanish rule in 1821, and Mexico became a federal republic in 1823.

People

Mexico's population has grown rapidly in the twentieth century more than tripling from 1940 to 1980. In 1991, it was 19 million, more than the combined populations of all the other Middle American countries and islands. Only one-third of the population lives in rural areas; 68 percent reside in towns and cities. Over one-half of the people in Mexico live in a zone that centers on Mexico City and extends from Veracruz in the east to Guadalajara in the west.

Sixty percent of Mexicans are mestizo, 29 percent are Indian, and 9 percent are European. Ninety-five percent are Roman Catholic. Spanish is the official language of Mexico. Five million Mexicans also speaking an Indian language and 1 million speaking an Indian language only. In addition to language, Mexican culture has been influenced by Indian dress, food, art, and architecture. In fact, Mexican culture is truly a mixture of both European and Indian cultural traits.

Economy

For almost 100 years after Mexican independence, most of the farmable land belonged to wealthy Spanish landowners who left much of the land uncultivated. Consequently, the country did not produce enough to feed its citizens. In 1910, a revolution to redistribute land began. The Constitution of 1917 made redistribution the law. Today, the government has redistributed over half of the cultivable land to mostly peasant communities. Although these communities tend to use outdated farming methods to grow Mexican staples (corn, beans, and squash) for their own consumption, commercial agriculture uses modern irrigation and farming techniques to produce high-value crops and livestock, like cotton, wheat, and cattle.

Since World War II, Mexico has enjoyed considerable economic growth. The country's mineral resources include silver, copper, zinc, and lead. Mexico is a leading producer of oil and natural gas. Manufacturing is also a source of economic wealth, especially in Mexico City and the border cities of Cuidad Juárez/El Paso and Tijuana/ San Diego.

Although the discovery of oil and natural gas brought Mexico great prosperity, the country borrowed heavily in the 1970s as oil prices soared. When oil prices fell it was saddled with a huge foreign debt it could not pay off. Today, Mexico continues to strive for improvements in industry and agriculture as it struggles with its huge national debt and a skyrocketing population growth rate.

CENTRAL AMERICA: A LAND OF UNREST

Central America (Illustration 5.2.1) occupies the narrow strip of land in the southernmost part of North America between Mexico and South America. The narrowest point in Central America spans 40 miles from the Pacific to the Caribbean and lies in Panama. The Panama Canal, constructed by the U.S. from 1904 to 1914, is a 51-mile long waterway cut across central Panama connecting the Atlantic Ocean, by way of the Caribbean Sea, to the Pacific Ocean. Instead of sailing around South America to get from the Atlantic to the Pacific (which can take about two weeks), ships can make the trip in seven to eight hours by way of the canal.

The interior of Central America is mostly mountainous, with low-lying coastal plains on both the Pacific and Caribbean sides. The area has an active zone of

volcanoes and earthquakes. The highlands and the Pacific side of Central America are more hospitable to human habitation than the Caribbean side which tends to have hotter, wetter weather. Much of the area receives adequate rainfall, with heavy rainfall in the east. Where rainfall exceeds 100 inches and humankind has left nature untouched, tropical rain forests thrive in Central America.

Important Historical/Political Considerations

Much of Central America's history parallels Mexico's history. Spanish explorers conquered the area along with Mexico. With the exception of Belize (formerly under British rule), Spain ruled Central America until the colonies declared independence — most in the early 1800s.

Since their independence, Guatemala, El Salvador, and Nicaragua have had a history of repressive governments, military rule, armed rebellions, terrorism, and civil war. Their proximity to Honduras, a democratic republic, has also caused that more stable country to suffer. As in Mexico, problems have occurred over the huge gap between wealthy landowners and the poor, and conflicts also exist between various Indian and mestizo groups.

In contrast to this political instability, Costa Rica, which has an old democratic tradition, has remained politically stable for most of the past 175 years. Panama, also a democracy, is buffered from the rest of Central America's strife by Costa Rica. Belize, Central America's only monarchy, is fairly stable as well.

People

In general, the majority of Central Americans are mestizo with Indian and white minorities. Exceptions include Guatemala where almost half of the population is pure Indian; Belize where half of the population is black or mulatto (of mixed black and white ancestry); and Costa Rica where there is a large majority of Spanish and relatively recent European immigrants.

Like Mexicans, the majority of Central Americans are Spanish-speaking Catholics; some speak Indian languages as well. Because of its British heritage, Belize is an exception: English is the official language and 35 percent of its population is Protestant. Many Panamanians also speak English, since Panama has had significant contact with the U.S. due to U.S. interest in the Panama Canal.

Many people in Central America become refugees, leaving their countries because of political and economic instability. Honduras is the poorest, least developed country in Central America, while Costa Ricans have the highest standard of living and a literacy rate and life expectancy more like that in the U.S.

Economy

Agricultural exports like bananas, coffee, and sugarcane, are the mainstay of Central America's economy. Unfortunately, political instability and feuds over the redistribution of farmland have hurt agriculture in many countries and discouraged foreign investment and tourism. The Caribbean-like Belize and stable Costa Rica, however, attract many tourists. Costa Rica also produces beef for export, and Panama earns much of its income from shipping through the use of the Panama Canal.

THE WEST INDIES: ISLAND PARADISE

The West Indies (Illustration 5.2.1) is an archipelago (a group of islands) that extends in an arc from Florida in North

America to Venezuela in South America. This arc separates the Caribbean Sea from the Gulf of Mexico and the Atlantic Ocean. Many of the islands are the tops of mountains rising from the floor of the sea. The islands divide into three main groups: the Bahamas, the Greater Antilles, and the Lesser Antilles.

The Bahamas consist of about 700 islands and 2,400 reefs. Because most of the islands are low, flat, and riverless, so people inhabit only about 20 of them. They begin 50 miles off the southeast coast of Florida and extend for 600 miles southeast into the Atlantic Ocean, ending near the island of Hispaniola. Hispaniola, divided into Haiti and the Dominican Republic, is part of the Greater Antilles along with Cuba, Jamaica, and Puerto Rico. These four islands located in the Caribbean Sea are the largest in the West Indies. The remaining smaller islands are known as the Lesser Antilles.

Important Historical/Political Considerations

In 1492, Columbus discovered the Bahamas, and European colonization of the entire Caribbean area quickly followed. Sugar plantations prospered at the expense of the Caribbean Indians, the original inhabitants, who perished in slavery. African slaves replaced them. Countries disputed over rights to many of the islands, and some islands passed from colonial power to colonial power. Today, most of the islands have gained independence.

The U.S. acquired Puerto Rico from Spain after the Spanish-American War (1898). In 1917, Puerto Ricans attained U.S. citizenship, and in 1952, the country became a self-governing territory of the United States. The U.S. purchased the 52 western Virgin Islands from Denmark in 1917, and the people of these islands became U.S. citizens in 1927. The 36 eastern Virgin Islands belong to England.

People

The West Indies is one of the most densely populated parts of North America. There are currently 34 million people living in the West Indies, almost 11 million of them in Cuba. Unlike the rest of Middle America, the original Indians of the Caribbean did not survive European colonization. Forced into plantation labor, they died by the thousands. The few hundred remaining Indians mixed with African slaves brought to replace them, and the pure Caribbean Indian disappeared.

With the exceptions of Cuba and Puerto Rico where the majority of people are of Spanish descent, people of African descent make up the majority in the West Indies. African heritage is visible in village construction, local markets, food, and art.

Because of the islands' history of European colonization, European influences also exist. For example, British influence survives in the Bahamas, Jamaica, and Grenada; Spanish influence can be seen in Cuba, the Dominican Republic, and Puerto Rico. French influence is evident in Haiti, Guadeloupe, and Martinique. Dutch customs are readily observed in the Netherlands Antilles. Likewise, languages spoken in the islands include English, Spanish, French, and Dutch. Because of this diversity, the people of the West Indies practice many religions, with Roman Catholicism the most predominant. In Cuba, which is a communist country, religious practice is discouraged.

Economy

The warm climate of the West Indies, the clear Caribbean waters, and the beautiful

beaches support a large tourist industry, particularly cruise ships. Yet, with the exceptions of Puerto Rico and Cuba, poverty is the rule in this area. Haiti is the poorest nation in the Western Hemisphere, and the slums in its capital, Port-au-Prince, are among the worst in the world. Agriculture (sugar, coffee, bananas, among other crops) is the main economic activity in the West Indies. Since the best land grows crops for export, rather than for local consumption, many local people are undernourished.

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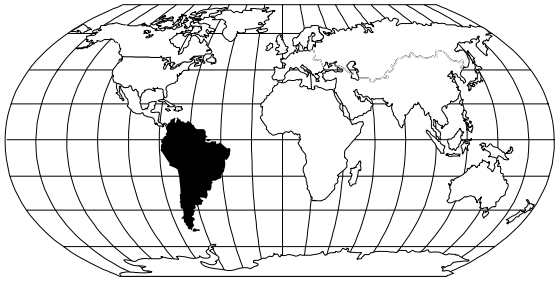
LESSON 3: SOUTH AMERICA — THROUGH THE TROPICS TOWARD ANTARCTICA



INTRODUCTION

South America (Illustration 5.3.1) is the fourth largest continent, extending about 5000 miles from north to south. It reaches farther south than any other continent except Antarctica, with its southern tip at Cape Horn only 620 miles from that frozen continent.

A principal physical feature of South America is the Andes Mountain System, which extends almost 5,000 miles from Venezuela in the north to Tierra Del Fuego (an archipelago divided between Chile and Argentina) in the south. The system widens in Bolivia and Peru, forming an altiplano, a high plateau between high mountain ranges. Like the North American Cordillera, the Andes follow the Pacific coast. They are rich in minerals, contain active volcanoes, and experience earthquakes.

Another principal physical feature of South America is the Amazon River, the second longest river in the world after the Nile. It flows almost 4,000 miles across the country from Peru through Brazil to the Atlantic Ocean. The Amazon drains almost half of the continent, carries more water than any other river in the world, and travels through the world's largest rain forest. There are no obstructions along the course of the river, and ocean-going vessels travel almost its full length. Other important rivers include the Orinoco River in the north and the Paraná River in the south.

Important grasslands in South America include the Pampas in Argentina and Uruguay, a 300,000 square-mile plain that supports livestock and agriculture; the Gran Chaco in Argentina and Paraguay, a lowland that supports livestock; and the Llanos, a savanna-like area in the Orinoco River basin in Colombia and Venezuela that has oil reserves and great agricultural potential yet to be tapped.

Also of note are the Atacama Desert in northern Chile, a coastal, desert plateau with great mineral wealth that is considered one of the driest places on Earth; Patagonia in the south, a semi-arid plateau rising from the Atlantic coast to the base of the Andes, also with great mineral wealth; the Galapagos Islands belonging to Ecuador that are famous for their unique geology, plants, and animals, includeing the giant tortoise; and the British-owned Falkland Islands which Argentina claims is theirs and tried unsuccessfully to take over in 1982.

IMPORTANT HISTORICAL/POLITICAL CONSIDERATIONS

Like North America before the arrival of the Europeans, Indians were the original inhabitants of South America, with the Incas creating the greatest South American Indian empire along the west coast. After conquering Middle America, the Spanish turned to conquering and colonizing South America, taking control of western and southern South America and forcing the Indian population into labor. In the meantime, the Portuguese claimed the east coast of South America and much of the South American interior. This area became Brazil. Because there were few native Indians living east of the Andes to use as labor, the Portuguese brought Africans to the continent to work on plantations.

Illustration 5.3.1

The remaining South American territories along the northeast coast (now Guyana, Suriname, and French Guiana) became British, Dutch, and French colonies, respectively. Africans, East Indians, and Indonesians (an island in southeast Asia) were brought or immigrated to this area to work on sugar plantations.

With the exception of French Guiana, which is an overseas department of France, the other South American countries gained their independence in the early 1800s. Since then, they have fought each other over territory and experienced political instability marked by military rule, oppressive dictatorships, and civil war — making it difficult for many of these countries to maintain democratic governments.

PEOPLE

Unlike North American, South America never drew a large European immigrant population, and its current population of about 302 million people is small for a continent of its size. More people live along the northwest, west, and east coasts of the continent, with few people living in the south, northeast, or interior. About half of the population lives in Brazil. Most of South America is still considered underdeveloped and standards of living are low. Many people move to the cities in hopes of finding work and a better life, so three out of four South Americans currently live in urban areas. Like other underdeveloped countries, however, many unskilled workers end up living in poverty in the crowded, rundown areas surrounding these cities.

A majority of South Americans are of European and/or Indian ancestry. The main European influences are Spanish and Portuguese, with most people speaking one of those two languages. In certain countries, however, many people also speak Native Indian languages. The majority of South Americans are Catholic.

REGIONS

ON THE CARIBBEAN: COLOMBIA, THE GUIANAS, AND VENEZUELA

Colombia, the Guianas, and Venezuela have their northern, Caribbean coastal location in common. All of them at one time had plantation economies, and today each country still has a tropical plantation area. Because of their plantation history, the countries' population mix, in addition to Spanish and South American Indian, includes people of African, East Indian, and Indonesian descent.

Colombia is the only South American country with both Pacific and Caribbean coastlines. The Pacific coast is swampy and humid, while the Caribbean side is dry and hot. Colombians grow sugar, tobacco, and coffee. Oil and coal are its other leading exports.

Unlike the majority of South America, the Guianas have British, French, and Dutch heritage. Because of this, English, French, and Dutch are official languages. Exports from this area include sugar, fish, lumber, rum, coffee, and bauxite, a principal source of aluminum.

Venezuela also exports coffee, and it is a leading oil producer of oil. One of the world's greatest oilfields is in Lake Maracaibo which is really a gulf open to the Caribbean Sea. Unfortunately, the lake now has major pollution problems due to oil spills. Venezuela is one of South America's wealthier countries because of its oil production. Like Mexico, however, it borrowed against its future oil profits and faces problems paying off its large foreign debt.

THE INDIAN REGION: BOLIVIA, ECUADOR, PARAGUAY, AND PERU

In west and central South America, the countries of Bolivia, Ecuador, Paraguay, and Peru have large Indian populations, almost 90 percent being Indian or mestizo. These Indian populations have very low incomes, and the region is the least urbanized in South America.

In the altiplano in Bolivia, freshwater Lake Titicaca, the highest large lake in the world, creates milder weather at its elevation of 12,500 feet and makes agriculture possible. Bolivians have grown grains in the area for centuries. They also export mineral oil, gas, zinc, silver, copper, and tin. Bolivia, however, is at a disadvantage economically because it is landlocked with no seaports of its own.

Ecuador is one of the leading exporters of bananas and is South America's second largest exporter of crude oil. Although it is not a poor country, the Indian population in the interior lives in poverty.

Paraguay is the only non-Andean country in this region. It is also the poorest. Its most important commercial activity is cattle grazing in the Gran Chaco. Like Bolivia, Paraguay is landlocked and must transport its exports of meat, timber, cotton, and tobacco on the Paraná River to Argentina's Buenos Aires. Possible oil reserves in the Gran Chaco could provide future income for both Paraguay and Argentina.

Peru's economic activities include a large fishing industry on the coast, and agriculture where mountain streams irrigate valleys in the coastal desert. These areas produce cotton and sugar for export, and rice, wheat, fruit, and vegetables for the country's consumption. Northeastern Peru has oil, and its rain forests supply nuts, rubber, herbs, and wood. The country also exports copper, zinc, silver, and lead.

The Andes are home to half of Peru's population, but the many Indians living there have little political or economic influence. Most work on their own small farms or are laborers on larger farms.

THE SOUTH: ARGENTINA, CHILE, AND URUGUAY

In southern South America, Argentina, Chile, and Uruguay have large European populations. Spanish is the official language, and the area is better developed economically than others on the continent.

Argentina's wealth comes from the Pampas that produce abundant livestock and grains. Transportation of the Pampas' products to Argentina's cities is on the densest railroad system in South America, which radiates from Argentina's capital, Buenos Aires. In the cities, manufacturing to process the Pampas' products is a major economic activity. In addition, Argentina has an oilfield in Patagonia, where sheep are also raised. In the future, there is also the possibility of oil drilling in the Gran Chaco.

Uruguay is also a prosperous, agricultural country because of the Pampas. Surrounding Montevideo, its capital, is the major agricultural area, producing vegetables, fruit, and wheat for the country's internal consumption. Raising sheep and cattle is the main economic activity in the rest of the country, and Uruguay's chief exports are wool, hides, and meat. Like Buenos Aires, railroads radiate from Montevideo into Uruguay's interior aiding in the transport of agricultural products.

Chile has the world's largest reserves of copper. Found mainly in the Atacama Desert, it has become Chile's major export. Most of Chile's population lives in middle Chile, where

agriculture is the chief economic activity. The area also supports cattle. In southern Chile, the coast breaks up into many islands, and few people live there.

BRAZIL: ON THE RISE

As the largest country on the continent, Brazil makes up its own region within South America. It is almost the size of all other South American nations combined. It is the fifth largest country in the world and the sixth largest in population. Interestingly, it is the only country in the world that intersects both the Equator and a tropic. The Amazon River basin takes up almost 60 percent of the country, gets heavy rainfall, and is covered in tropical forest. The Brazilian Highlands cover much of the rest of Brazil, with steep cliffs and slopes dropping to sea level along the coastline and leaving little coastal living space.

Brazil's heritage gives it a strong national culture, with one dominating language, Portuguese, and one main religion, Catholicism. Because of the millions of African slaves brought to work on Brazil's sugar plantations, Brazil has South America's largest black population. About 12 percent of Brazilians are black, 30 percent are of mixed African, white, and Indian ancestry, and more than half are of European descent. Indians make up a very small minority.

Brazil's economy is on the rise in the world because of its abundant natural resources, rapid urbanization, growing industry, enormous mineral deposits, and major oil and gas fields. It has built huge hydroelectric plants, including the world's largest dam, the Itaipu, which is 600 feet high and five miles long.

In agriculture, Brazil is a leading producer and exporter of coffee, soybeans, and oranges.

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LESSON 4: EUROPE —THE PENINSULAR CONTINENT

Celtic
clans
fjords
geysers
Gulf Stream
Orthodox Church
Slavs

INTRODUCTION

Some geographers consider Europe and Asia as one continent, Eurasia. It is generally accepted, however, that Europe and Asia are two separate continents, with Europe taking up the vast western peninsula of the European/ Asian landmass. The Ural Mountains, Caspian Sea, Caucasus Mountain System, Black Sea, and Bosporus and Dardanelles Straits (Illustration 5.4.1) separate Europe from Asia.

Although Europe, the second smallest continent, is itself a peninsula, it also consists of many peninsulas surrounded by many seas (Illustrations I and J) including:

- The Scandinavian Peninsula, home to Norway and Sweden, between the Norwegian and Baltic Seas
- The Kola Peninsula in Russia on the Barents Sea
- The Jutland Peninsula, home to Denmark and part of Germany, between the North and Baltic Seas
- The Iberian Peninsula, home to Portugal and Spain, west of the Mediterranean Sea and separated from the African continent by the Strait of Gibraltar
- The Italian Peninsula, home to Italy, Vatican City, and San Marino, on the Mediterranean and Adriatic Seas
- The Balkan Peninsula, home to Greece, Bulgaria, European Turkey, Albania, Macedonia, Yugoslavia, Bosnia-Herzegovina, Croatia, Slovenia, and part of Romania, on the Mediterranean, Adriatic, Aegean, and Black Seas
- The Crimean Peninsula, which is part of the Ukraine, on the Black Sea.

Entering the many seas of Europe are major rivers, including the Volga, Danube, Dnieper, and Rhine. The Volga is the longest river in Europe, flowing south through Russia to enter the Caspian Sea. The Danube starts in Germany, flows through or creates borders with eight countries (Austria, Slovak Republic, Hungary, Croatia, Yugoslavia, Bulgaria, Romania, and Ukraine), and enters the Black Sea. Also flowing into the Black Sea is the Dnieper, passing through Russia, Belarus, and the Ukraine. The Rhine River is the main waterway of western Europe. It rises in Switzerland, forms part of the Germany-France border, then flows through the Netherlands to the North Sea.

The source of the Rhine River is the Alps, the principal mountain range of Europe, which passes through Switzerland, France, Germany, Austria, Liechtenstein, Italy, Slovenia, Croatia, and Yugoslavia. The Alps are part of the Alpine Mountain System that crosses Europe from west to east. Other important mountain ranges in the Alpine Mountain System are the Pyrenees which separate France from Spain and are home to the country of Andorra; the earthquake prone Apennines that extend down the Italian Peninsula; the Carpathians extending from the Czech Republic along the Poland-Slovak Republic border into the Ukraine and Romania; and as previously mentioned, the Caucasus Mountains.

DID YOU KNOW?

The Caspian Sea is not really a sea. It is the largest lake in the world — over 140,000 square miles.

Another important physical feature of Europe is the North European Plain that stretches from the Atlantic coast of France to the Ural Mountains in Russia. The area is a lowland, much of it below 500 feet in elevation. It contains Europe's best farmland, where the practices of agricultural diversity and high productivity help feed Europe's large population — about 25 percent of the Earth's total population in an area about half the size of the U.S.

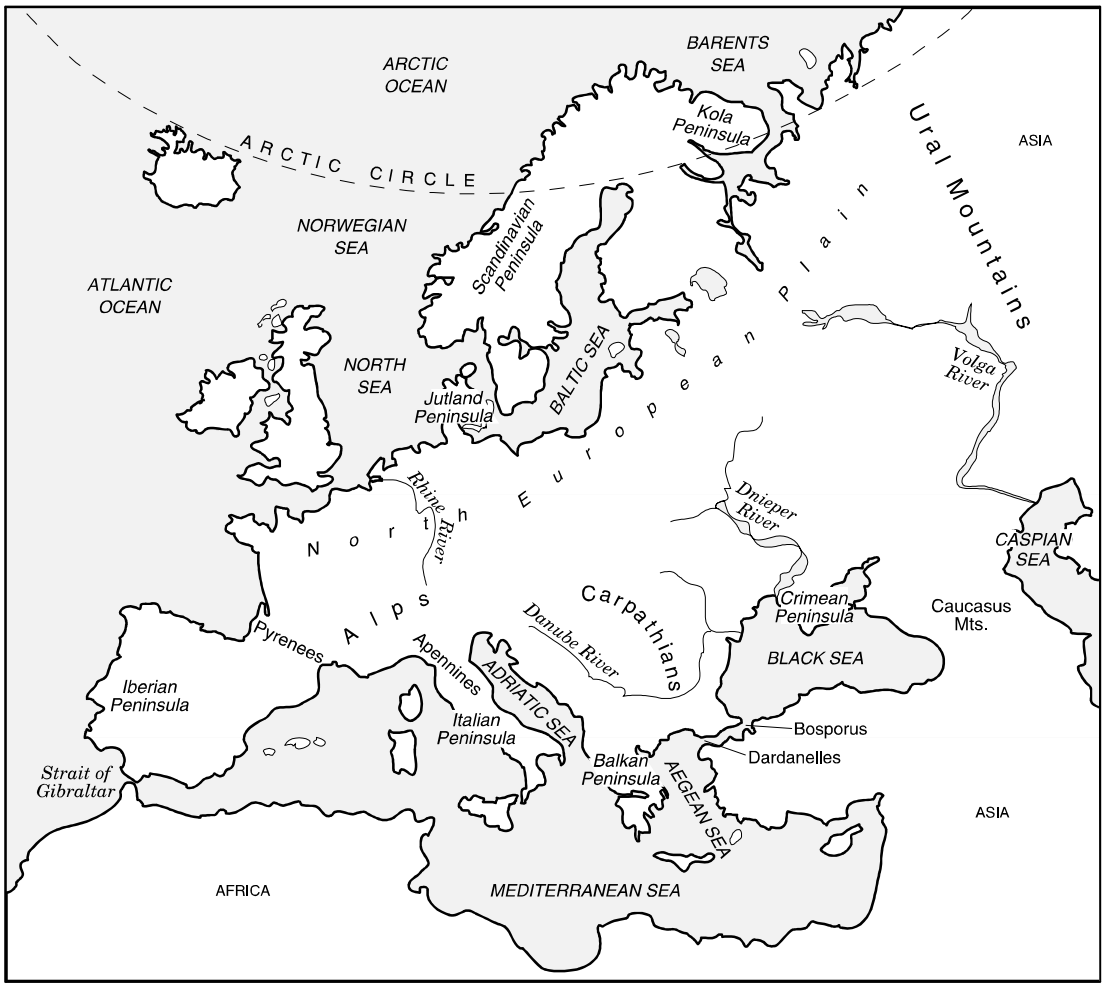


Illustration 5.4.1

People of very different backgrounds and cultures exist together on this small continent, which is home to over 40 different countries. Historically, European countries have been economically and politically fragmented, their borders shaped by conflict and the rise and fall of political powers. Yet, Europe also has a history rich in science, art, literature, music, religion, commerce, world exploration, and industry. Today, Europe continues to possess thriving cities, excellent transportation networks, high productivity, and innovative technology.

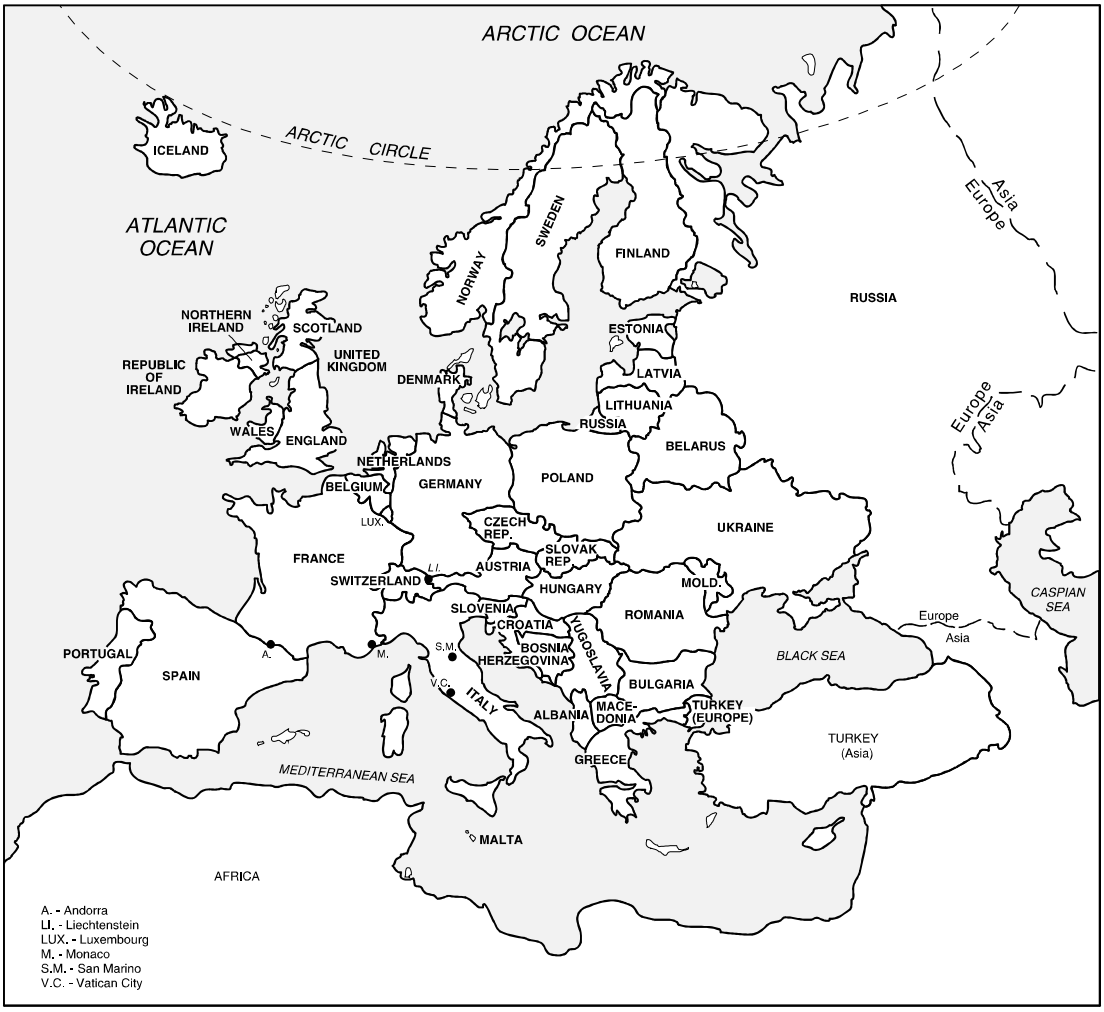


Illustration 5.4.2

In western Europe, 11 countries formed the Economic and Monetary Union, and in the pursuit of economic unity, created one currency, the euro, which was issued in 2001. In contrast, many countries in eastern Europe are struggling with internal conflicts and economic problems following the dissolution in the early 1990s of the U.S.S.R., of which many were a part.

THE BRITISH ISLES: GREAT BRITAIN AND IRELAND

The British Isles (Illustration 5.4.3) are home to the United Kingdom (England, Scotland, Northern Ireland, and Wales) and the Republic of Ireland. They consist of two large islands, Great Britain and Ireland, and smaller islands off their coasts. The North Sea and the English Channel, which is one of the world's busiest shipping lanes, separate the British Isles from mainland Europe. London, located on the Thames River, is the capital of England and the United Kingdom. The Pennines Mountain Range is "the backbone of England," and the Highlands in Scotland is a mountainous region known for its rugged beauty and distinctive culture based on **clans**. The British Isles tend to have wet weather, with Ireland receiving the heaviest rainfall.

DID YOU KNOW?

The Highlands region has many lochs, or almost landlocked arms of the sea, including Loch Ness, which many people claim contains the "Loch Ness monster."

IMPORTANT HISTORICAL/POLITICAL CONSIDERATIONS

From 1801 until 1922, all of Ireland was part of the United Kingdom; however, the Irish, especially the large Catholic population, fought British rule. In the 1920s, Britain divided Ireland — Northern Ireland was mostly Protestant and stayed in union with the United Kingdom, while the rest of Ireland eventually became the Republic of Ireland.

Illustration 5.4.3 — The British Isles

PEOPLE

The United Kingdom is one of the most densely populated nations in Europe. Of the United Kingdom's 57 million people, England has the largest population, with 20 million people living in and around London. In contrast, Ireland has a shrinking population. Each year, 30,000 Irish leave their country, usually because of Ireland's economic problems. Since 1999, however, these problems seem to be on the decline due to Ireland's promotion of new industries, trade, and foreign investments.

The population of the United Kingdom is 81 percent English, 10 percent Scottish, 2 percent Irish, 2 percent Welsh, and 2 percent Asian and African from former British colonies. English is the universal language of the British Isles, with **Celtic** languages (Welsh, Irish Gaelic, and Scots Gaelic) spoken as well.

Like North and South Americans, people from the British Isles are overwhelmingly Christian. In the United Kingdom, a majority of people are Protestant, in contrast to the Republic of Ireland where the majority are Catholic. Since the 1960s, Northern Ireland has experienced violence between Catholics and Protestants based on Catholic claims of discrimination and Protestant fears of reunification with the Republic of Ireland.

ECONOMY

The United Kingdom is a leading industrial nation. Yet, because of its small size, it lacks the raw materials needed for industry, therefore it exports manufactured goods in exchange for the raw materials and food needed for its large population. This makes the United Kingdom one of the most active trading nations in the world. Industries include food processing, publishing, shipbuilding, and production of oil and gas from the North Sea. Other economic activities include agriculture, livestock, fishing, and tourism.

In the Republic of Ireland, agriculture is the primary economic activity, with much of the land used for grazing sheep and cattle. Tourism is also a large source of income. Other economic activities include fishing, forestry, and a recent growth in engineering, electronics, and software development.

WESTERN EUROPE: THE CONTINENTAL CORE

Western Europe (Illustration 5.4.4) consists of Andorra, Austria, Benelux (created when Belgium, the Netherlands, and Luxembourg formed a trade union in 1948), France, Germany, Liechtenstein, and Switzerland. Territorially, France is the largest country; Liechtenstein is the smallest comprise of just 62 square miles.

Physically, the region possesses a variety of landscapes. The Alps in France, Switzerland, and Austria contrast with the extremely flat land of Benelux, also referred to as the Low Countries because they lie near sea level. In the Netherlands, more than 25 percent of the land is actually below sea level; the Dutch have claimed land from the sea by connecting coastal islands in the North Sea with dikes, then pumping out the trapped water.

Like the Netherlands and Belguim of Benelux, Germany and France also have coastlines. The rest of the countries in western Europe are landlocked, and rely on rivers connected by canals and artificial waterways.

PEOPLE

Like the United Kingdom, the countries of western Europe are densely populated. Comparing size and population, the countries of Benelux are some of the most densely populated on Earth. Twenty-five million people inhabit an area about the size of the state of Maine. Maine, by comparison, contains only 1.2 million people.

Like the British Isles, a majority of people are Christian. Unlike the British Isles, the countries of western Europe do not share a common language. In the Netherlands, Dutch is the official language. In Germany, Austria, and Liechtenstein, a majority of the people speak German. In Luxembourg, both German and French are official languages, although the common language is Luxembourgish, a form of German. In Switzerland, German, French, and Italian are spoken. French is the official language of France.

In Belgium, more than half of its people are Flemings, natives of Flanders who speak Flemish, a Dutch language; while a third are Walloons, inhabitants of southern Belgium who speak French. Political tensions between the Flemings and Walloons caused the collapse of several governments; and in 1989, a new constitution split Belgium into three regions: Flanders, Wallonia, and the bilingual city of Brussels.

ECONOMY

Industry and commerce make western Europe the continental core. Many internationally important cities in the region include Brussels, Belgium, which is headquarters of the European Union and NATO; Geneva, Switzerland, which is headquarters to over 200 international organizations, including the International Red Cross and the World Health Organization; Paris, France, one of the world's main tourist destinations and a world center of art, high fashion, and luxury goods; and Rotterdam in the Netherlands, which is one of the largest ports in the world.

Switzerland, with a history of political stability and neutrality, strong commerce, and technological advancement, is one of the richest countries in the world. It is famous for cheese, chocolate, watches, and banking. Luxembourg is another important banking center. Belgium is one of Europe's most heavily industrialized nations. In addition to industry, the Netherlands boasts a large agricultural base.

France, however, is Europe's leading agricultural producer. Although wheat is its

major crop, the country has enormous agricultural diversity, and French wine and cheese are world-famous. France also specializes in high-quality textiles and precision equipment. It is active in the telecommunications, biotechnology, and aerospace industries.

In Germany, a division exists between the economies of old East and West Germany (separated by a Soviet blockade in 1949 and reunited following the fall of the Berlin Wall in 1989). Because of the east's previous socialist economy, it has limited industrial development compared to the west. Despite these problems, Germany has a strong economy. It exports high-technology goods and among its most famous exports are its automobiles, which include BMW, Mercedes, Porsche, and Volkswagen.

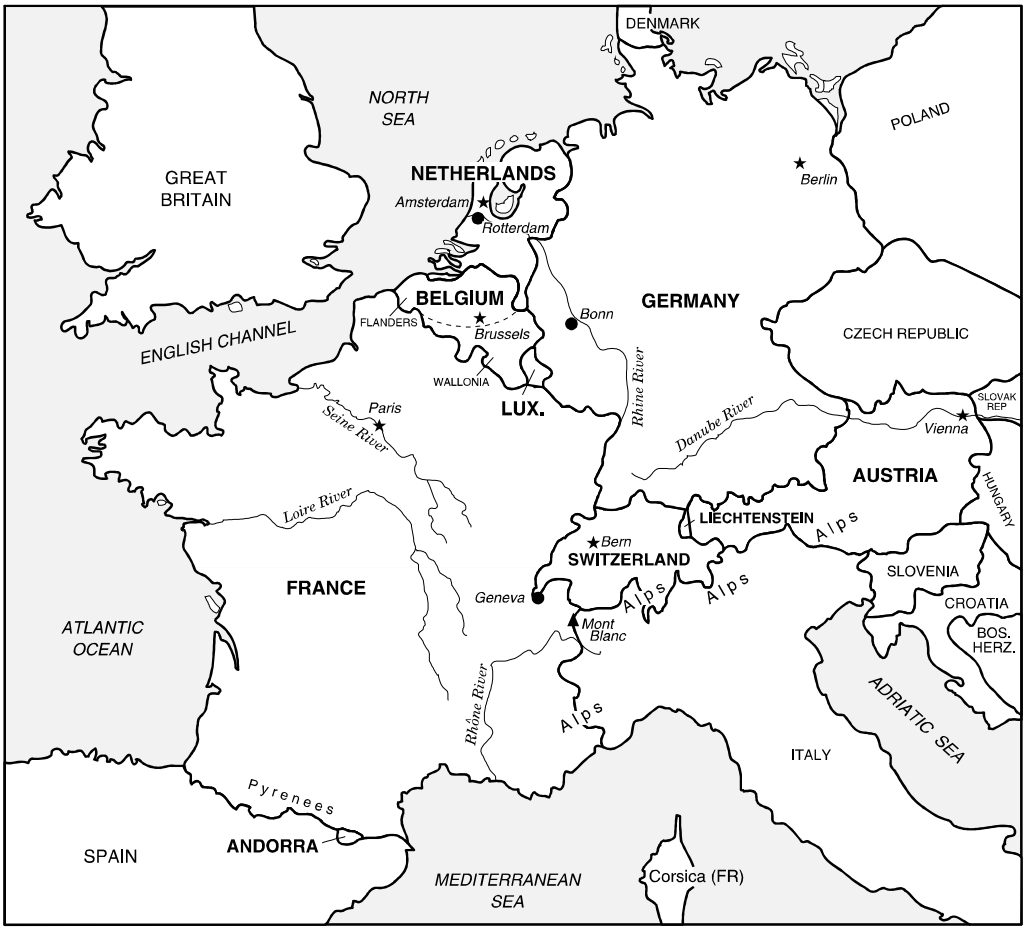


Illustration 5.4.4 — Western Europe

SCANDINAVIA: THE NORTHERNMOST COUNTRIES

For historical, ethnic, and geographical reasons, Scandinavia (Illustration 5.4.5) consists of Norway and Sweden on the Scandinavian Peninsula, as well as Denmark, Finland, and Iceland. These are the world's northernmost countries. The U.S., Canada, and Russia all have territory at similar latitudes, but they also possess more southerly land.

Norway's coastline is irregular with many islands and **fjords**. Its interior is mountainous, with much of it over 5,000 feet in elevation. The Kjölen Mountains in the north form a border with Sweden. Forest covers over half of Sweden and Finland, and both countries have much inland water in the forms of rivers and lakes. Unlike Norway and Sweden, Finland and Denmark are low-lying countries. Iceland has snowfields and glaciers as well as active volcanoes, hot springs, and **geysers**. Underground hot water heats many towns in Iceland, and warm water from the **Gulf Stream** flows around the country keeping its ports ice-free.

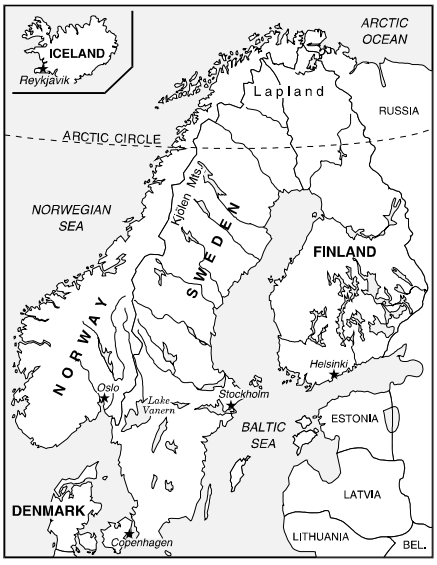


Illustration 5.4.5 — Scandinavia

PEOPLE

For its size, Scandinavia has a small population with most people living in the southern portion of the region. People from Scandinavian countries have much in common. Most have a high standard of living; and not only are a majority Protestant, over 90 percent of all Scandinavians are specifically Lutheran. Each country has its own language, yet Danish, Swedish, and Norwegian are mutually understandable. These three languages and Icelandic are of German origin. Only Finnish is totally different, but many Finns also speak Swedish.

In the Arctic region of Scandinavia, known as Lapland, there is a Lapp minority believed to have originated in central Asia. The Lapps use the reindeer as a pack animal as well as, for milk, meat, leather.

ECONOMY

Denmark's level land and good soil support intensive agriculture. Estimates indicate its farm production could feed 20 million people a year. Since Denmark has few natural resources, it trades exports for raw materials to support processing industries. One famous Denmark product is Lego toy building blocks. Unlike Denmark, only three percent of Norway's land is under cultivation, and one of its important economic activities is the extraction and processing of raw materials including North Sea oil. Both its fishing industry and its merchant marine are among the world's largest. Similarly, three-fourths of Iceland's income comes from fishing.

Chief exports of both Finland and Sweden are wood products. Both have shifted from traditional economic activities of farming and forestry to industries like electronics, food processing, and chemical manufacturing. Bordering Russia, Finland has experienced

economic problems due to changes in the former Soviet Union and eastern Europe in the 1990s.

MEDITERRANEAN EUROPE: PENINSULAS AND ISLANDS

Greece, Italy, Malta, Monaco, Portugal, San Marino, Spain, and Vatican City make up Mediterranean Europe (Illustration 5.4.6). Like Scandinavia, this region consists of many peninsulas and islands. In addition to the Iberian and Italian Peninsulas (recall Illustration 5.4.1), the southern part of the Balkan Peninsula is a peninsular region of Greece known as the Peloponnese. Over 1,400 islands make up 20 percent of Greece, with Crete being the largest.

Most of Mediterranean Europe is mountainous or hilly. As in western Europe, the Alps and Pyrenees Mountains are important physical features of this region. Other features include the Apennine Mountains that run through Italy and are home to San Marino, a 23 square mile republic land-locked in Italy; the 2.5 square mile city of Gibraltar on the Strait of Gibraltar, which the United Kingdom owns and Spain wants; the Italian city of Venice, built on 118 islets in a lagoon, allowing transportation by boat only through a system of canals; and the rivers Tagus, Ebro, Po, and Tiber.

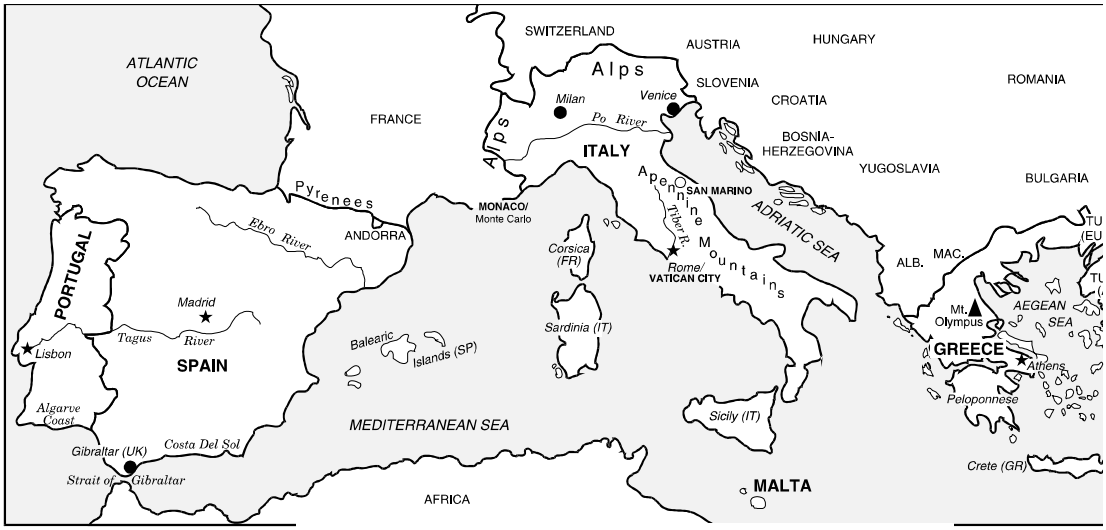


Illustration 5.4.6 — Mediterranean Europe

The Tiber River flows through Rome, Italy, an important historical and cultural city for more than 2,000 years. Located in Rome on the Tiber is Vatican City, the smallest independent nation in the world at less than one-fifth of a square mile. Often called simply the Vatican, it is the world center of the Catholic Church and home of the pope, who is its spiritual leader. Although the Vatican is small, decisions made there by the pope often affect politics in other predominantly Catholic countries. His influence is particularly great with laws on moral issues.

PEOPLE

In general, the people of Mediterranean Europe have a lower standard of living than

their neighbors in western Europe, Scandinavia, and the British Isles. Monaco, a luxury resort area that is home to many wealthy people, is an exception. Of the larger Mediterranean countries, Portugal and Greece have the lowest standards of living. Although its island of Sicily still has much poverty, Italy, in general, has the highest standard of living in the region.

Whereas Spain has the largest territory, Italy has the largest population at 57 million — almost equal to Portugal, Spain, and Greece combined. Yet, the smaller countries are the most crowded, especially Malta. Except for the Greeks, most of whom belong to the **Orthodox Church**, the majority of people in Mediterranean Europe are Roman Catholic.

Like western Europe, languages in Mediterranean Europe differ from country to country: Greek in Greece; Portuguese in Portugal; Italian in Italy and San Marino; English and Maltese (a mixture of Arabic and Italian) in Malta; and French in Monaco. Latin, an ancient language from which the Romance languages evolved, is the official language in Vatican City. In Spain, Spanish is the official language, but other dialects and languages spoken are Catalan and Basque.

The Basques, located in north Spain and southwest France, are probably Europe's oldest ethnic group. The majority live in Spain and preserve their unique traditions and ancient language, unrelated to any present-day European language. Many Basques desire political independence, and some engage in terrorism to force the establishment of a Basque state.

ECONOMY

The warm climate in Mediterranean Europe makes tourism an important economic activity, while dry summers and rocky soil make agriculture difficult in many areas. The region lags behind much of western Europe in industrial development.

Greek islands and ancient structures still standing in Athens make Greece a major tourist attraction, with the service sector accounting for almost 60 percent of Greek income. Other industries include shipping (Greece's maritime fleet is one of the largest in Europe), textiles, food processing, and chemicals. Agricultural exports include grapes, olives, and olive oil. Olives and grapes are also the main crops in Spain where industry supplements a traditionally agricultural economy. Since the late 1980s, Spain's economy has grown at a fast rate. High-technology industries, resorts, and retirement communities have multiplied, especially along the Mediterranean coast.

Exports of Portugal include textiles, shoes, leather, and wood products from the large forests covering 20 percent of the country. Tourism is important, especially in the south on the Algarve Coast. Tourism is a major economic activity in Monaco, known for its beautiful location, mild climate, and world-famous gambling casinos in Monte Carlo.

In northern Italy, agriculture and industry prosper. The area around the Po River valley is a major agricultural region, and fruit, nuts, and grapes grow in the foothills of the Alps. Milan is the leading manufacturing center in Mediterranean Europe. Its factories are world-famous for their efficiency and speed. Known for its fashion and footwear, Italy produces machinery, automobiles, and textiles.

EASTERN EUROPE: IN TRANSITION

Political instability, changing boundaries, and internal ethnic and religious problems mark the countries of eastern Europe. Although not all of these countries were part of the U.S.S.R., communist parties and communist economics controlled this region for much of

the twentieth century. With the collapse of the Soviet-dominated communist system in the late 1980s and early 1990s, many problems surfaced as countries declared their independence and struggles for political control and economic reform began. At the turn of the century, eastern Europe remains an area in transition.

EUROPEAN RUSSIA

In its entirety, Russia is the largest country in the world, stretching more than six million square miles from eastern Europe across northern Asia to the Pacific. European Russia (Illustration 5.4.7) is Russia's core area with major industry and transportation networks, well-cultivated land, and a large portion of Russia's population. This area also has many large cities including Moscow, Russia's capital and largest city, and St. Petersburg (formerly Leningrad), a Baltic port and Russia's second largest city.

Except for the Caucasus and Ural Mountains, most of European Russia is flatland consisting of the fertile Russian Plain (part of the North European Plain) and drained by the Volga and Don Rivers.

People

After years of living under restrictive and repressive government regulations, the Russian people witnessed a move in the late 1980s toward greater cultural freedom, freedom of the press, and open public debate. This move was part of the policy of *glasnost*, or openness of information, that affected not only Russia but the rest of eastern Europe as well.

Illustration 5.4.7 — European

Russians make up part of Europe's largest ethnic group, the **Slavs**. Over 80 percent of Russia's total population is Russian with over 100 other ethnic groups making up the rest. Russian, a Slavic language, is official, with over 100 other languages spoken as well. Many people are non-religious, but 25 percent consider themselves Orthodox. There is also a Muslim minority.

Economy

Since the late 1980s, Russia has restructured its communist economy in a move toward capitalism. Currently it is struggling with legal problems related to private property, food and fuel shortages, unemployment, and cutback or suspension of social services. European Russia has a wealth of mineral resources in the Ural Mountains as well as oil and natural gas along the Volga River. The greatest industrial regions are around Moscow and along the Volga. Fruit and tobacco are major export crops.

THE NORTHERN COUNTRIES

The remaining northern countries in eastern Europe include Belarus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, the Slovak Republic, and the Ukraine (Illustration 5.4.8). The lands of Belarus, Estonia, Latvia, Lithuania, and Poland are covered in part by the North European Plain, while the Carpathian Mountains begin in the Czech Republic and extend through southern Poland and the Slovak Republic.

People

The majority of the populations of the Czech Republic, Hungary, and Poland are Czechoslovakian, Hungarian, and Polish, respectively. The populations of the remaining countries are a diverse mix of ethnic groups. (**Note:** Through the rest of this unit, names of ethnic groups and languages discussed are numerous and may be more unfamiliar to you than those covered previously. The point is not that you must specifically know the names of each region's ethnic groups and languages, but that you gain an appreciation for the diversity of people living in the different regions discussed.)

The Belorussians, Czechoslovakians, Poles, Slovaks, and Ukrainians are of Slavic origin, like the Russians. Likewise, the official languages of these countries (Belorussian, Czechoslovakian, Polish, Slovak, and Ukrainian, respectively) are Slavic languages like Russian. The Hungarians (or Magyars) and the Hungarian language (or Magyar) are of Asian origin. The Moldovans and the Moldovan language are essentially Romanian, since the Soviets took Moldova from Romania in the 1940s. Latvian and Lithuanian are related languages, while the Estonians and their language bear similarities to their neighbors, the Finns. Most people in this region are Christian (a mix of Protestant, Roman Catholic, and Orthodox).

Illustration 5.4.8 - Eastern Europe

Economy

Under communist rule, much of the agriculture and industry in this region came under government control. However, in Hungary in the 1960s, individual farms and factories gained greater independence. This mix of capitalism and communism allowed the Hungarian economy to progress. Much of Hungary is flat farmland, and its industries include engineering, chemicals, textiles, food processing, and mining.

Much of Poland is also flat farmland, and over 50 percent of it is under cultivation. Poland is a major producer of coal and has huge shipbuilding factories. The Ukraine contains the 10,000 square mile Donets coalfield and has been in heavy industry since the late 1800s. It has a wide variety of natural resources, but limited water resources. With its fertile soils, the Ukraine is a major exporter of grain.

Forty-six percent of Belarus is farmland, and Moldova has fertile soils that produce grapes for wine. The Czech Republic has coal and iron, while the Slovak Republic is

more of an agricultural region. Both produce steel; however, since the division of Czechoslovakia, heavy industry in the Slovak Republic has suffered due to loss of state subsidies. The economy of the Baltic Republics (Estonia, Latvia, and Lithuania) relies on manufacturing, agriculture, livestock, and fishing.

THE SOUTHERN COUNTRIES

The remaining countries in eastern Europe lie entirely or partially on the Balkan Peninsula. Often referred to as the Balkan States, they include Albania, Bulgaria, Bosnia-Herzegovina, Croatia, Macedonia, Romania, Slovenia, European Turkey, and Yugoslavia (Illustration 5.4.9). (**Note**: Turkey will be discussed in its entirety in the lesson about Asia.) Except for land near the Danube River, most of this region is mountainous. It contains the Dinaric Alps which are part of the Alpine Mountain System; Balkan Mountains; and Carpathian Mountains which include the Transylvanian Alps in Romania. All but Macedonia, which is landlocked, have coastlines on the Adriatic or Black Seas.

Important Historical/Political Considerations

This region is the most troubled in Europe. In fact, because of the Balkan States' reputation for division and fragmentation, the term "balkanize" means "to break into small and often hostile units." As late as the 1990s, civil war occurred when the former Yugoslav Republics of Bosnia-Herzegovina, Croatia, Macedonia, and Slovenia declared their independence leaving Yugoslavia with only Serbia and Montenegro. Fighting occurred between ethnic and religious groups in Croatia and Bosnia-Herzegovina. NATO conducted bombing raids against Serbian forces in Serbia to halt hostilities against ethnic Albanians in the Serbian province of Kosovo.

People

Like the northern countries of eastern Europe, the southern countries have a mix of ethnic groups (Albanian, Bulgarian, Romanian, Slovene, Slavic, Serbian, Croatian, and Turkish) and languages (Albanian, Serbo-Croatian, Bulgarian, Macedonian, Romanian, and Slovene). Unlike their northern counterparts that have mainly Christian populations, many of the southern countries have a mix of Christians (Orthodox and Roman Catholic) and Muslims.

Economy

This region is one of the poorest parts of Europe, with Albania being the poorest country in Europe despite its rich mineral resources. Albania is attempting industrial expansion especially in oil, mining, chemicals, and natural gas. Bulgaria is less industrial than other countries in this region. Much of its land, collectivized in the 1950s, is being returned to former owners or privatized. The state owns a third of the farm land in Romania, which moved from agriculture to industry after World War II.

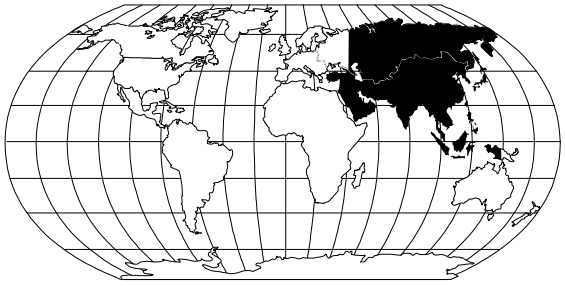
Yugoslavia's industry has also grown since World War II. The country has natural resources like copper, coal, and timber, as well as fertile valleys for agriculture. However, its economy and the economies of its former republics, have been badly affected by civil war.

Illustration 5.4.9 — Eastern Europe — The South

LESSON 5: ASIA — THE LARGEST, MOST POPULOUS CONTINENT

atheist
Buddhist
Confucianism
homogenous
monsoon
sultanate

INTRODUCTION



At over 17 million square miles, Asia is the largest continent possessing more than a third of the world's total land. A sprawling realm of diverse terrain and climate, it is also the most populated continent with more than 3 billion people or 60 percent of the Earth's population. Site of some the earliest civilizations, today Asia is a complex mosaic of languages, races, religions, and politics. Although over half of Asia's land is claimed by only 2 countries, China and the Asian portion of Russia, 46 countries make up the remaining half (Illustration 5.5.1).

The Asian landscape (Illustration 5.5.2) is full of extremes and record-breaking measurements. Stretching 1,500 miles across the continent is the highest mountain system in the world, the Himalayas. They rise over 29,000 feet at Mount Everest, the highest mountain in the world, and include the Karakoram Range among others. The Hindu Kush, the world's second highest mountain range, is an extension of the Himalaya Mountain System. Other important mountain ranges in Asia include the Tien Shan and Altai.

DID YOU KNOW?

The 28 highest mountains in the world are in Asia, with the 10 highest located in the Himalayas.

Other highlands in Asia include the Plateaus of Mongolia and Tibet. At an average altitude of 13,000 feet, the Plateau of Tibet is the world's highest plateau, covering almost one million square miles. On another plateau ranging from 3,000 to 5,000 feet in altitude is the Gobi Desert, which covers almost 500,000 square miles.

In contrast, the Dead Sea is the lowest point on Earth at 1,312 feet below sea level. The Dead Sea is one of the most saline lakes in the world, and contains no life.

Two other important Asian lakes are Lake Baykal, the deepest lake in the world with a maximum depth of 5,315 feet, and the Aral Sea. Once the world's fourth largest lake, it is now less than half its original size because of water diversion for cotton irrigation.

The rivers in Asia play an important role in ancient history as well as in the lives of Asians today. Many of the world's first great civilizations developed in the river valleys of the Tigris and Euphrates, Indus, and Huang He (Yellow) Rivers. Three of the

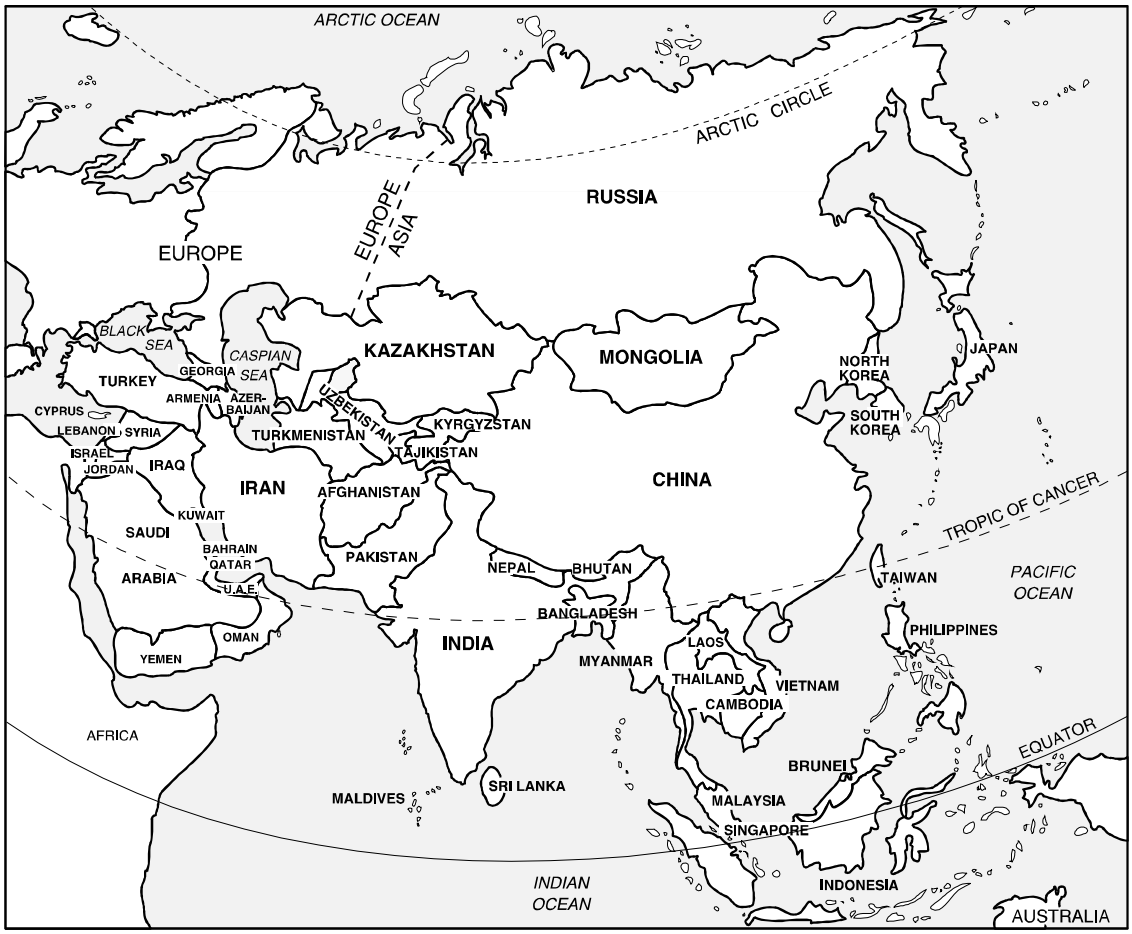


Illustration 5.5.1 — Asian Countries

greatest population densities in the world are along the Ganges, Yangtze, and Huang He Rivers. Other rivers of note include the Mekong, Amur, Lena, Yenisey, and Ob. The latter three rivers are in Siberia, a vast region of Asian Russia known for its harsh climate and used as a prison colony.

Other important geographic regions of Asia include the Arabian, Kamchatka, and Malay Peninsulas, and Asia Minor, a peninsula that forms Asian Turkey.

IMPORTANT HISTORICAL/POLITICAL CONSIDERATIONS

Asia was the birthplace of great civilizations, religions, and philosophy. The Chinese, Indians, and Muslims made major contributions to medicine, mathematics, astronomy, and literature. The Japanese developed a strict military code of behavior. At its peak (750 to 1200 A.D.) the Muslim Empire under the control of the Turks and the Arabs, stretched across northern Africa, Mediterranean, and southeastern Europe, southwestern Asia and parts of India acted as a buffer between Christian Europe and eastern Asia until the 1400s when Europeans found a sea route around Africa.

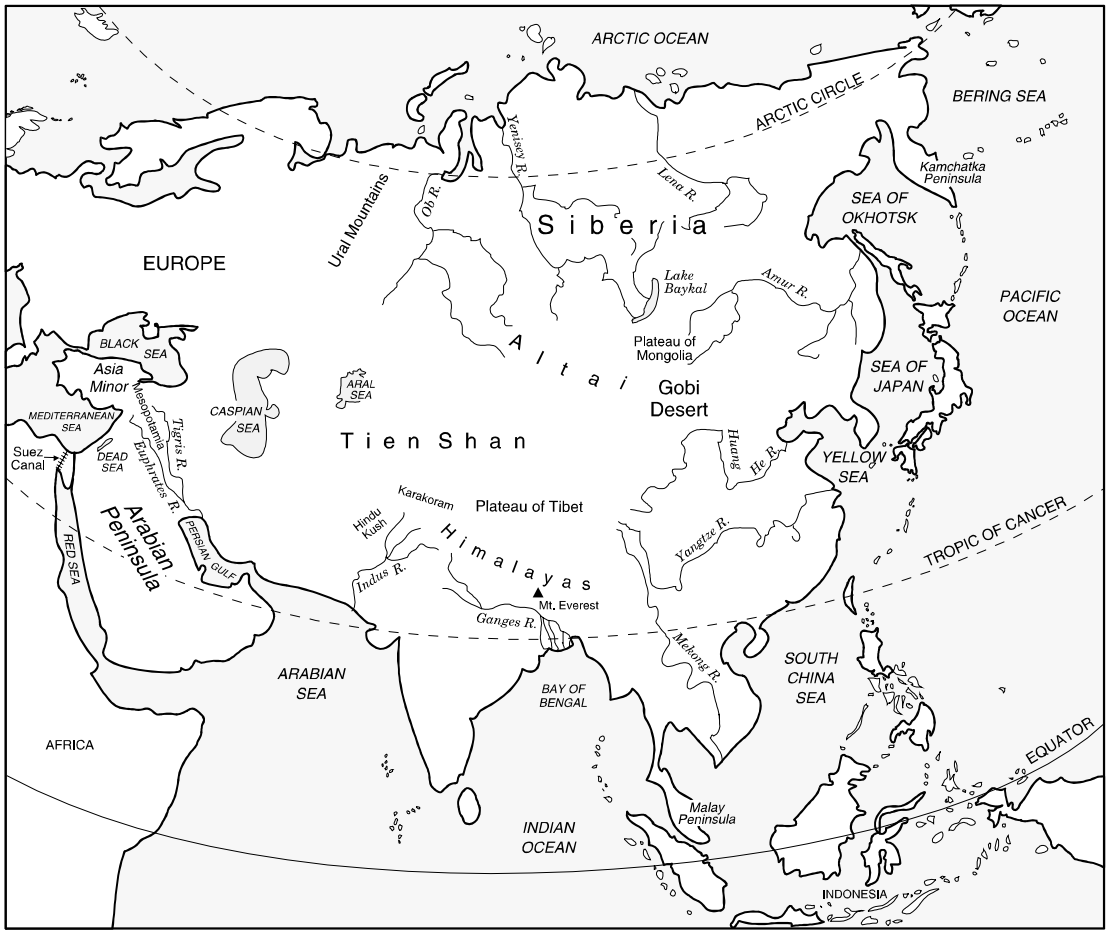


Illustration 5.5.2 — Asian Terrain

After the 1500s, European colonialism, as well as Russian and Japanese expansion greatly affected the borders within Asia. The opening of the Suez Canal in 1869, which connected the Mediterranean Sea to the Red Sea, aided this expansion by providing easier access to eastern Asia. Following World War II, foreign influence in Asia gave way to Asian nationalism with many countries gaining their independence. However, a return to self-rule in Asia was not without problems, and political, ethnic, and religious conflicts erupted — among them the Korean, Vietnam, Arab-Israeli, and Iran-Iraq Wars. Conflicts still affect many Asian countries today.

RUSSIA, CENTRAL ASIA, AND TRANSCAUCASIA

This region (Illustration 5.5.3) includes all the former Soviet Socialist Republics in Asia: Russia, the central Asian republics, and the three republics of Transcaucasia (the area south of the Caucasus Mountains and north of Turkey and Iran.) In Asian Russia, the West Siberian Lowlands extend from the Ural Mountains to the Yenisey River. The Central Siberian Plateau then extends to the Lena River.

Illustration 5.5.3

The five central Asian republics are located east of the Caspian Sea. Both Kyrgyzstan and Tajikistan are mountainous. Kazakhstan, the second largest republic of the former U.S.S.R. at over one million square miles, is steppe land (prairie) and desert. Most of Uzbekistan is a sandy plain, and desert covers 80 percent of Turkmenistan. Much of the area experiences very hot summers and freezing winters.

Much milder weather exists in the small, mountainous republics of Transcaucasia (Armenia, Azerbaijan, and Georgia). Note that Armenia splits Azerbaijan into two parts.

PEOPLE

Like the countries of eastern Europe, the countries of this region possess a mix of ethnic groups. (For Russia, refer to the section on European Russia which covers both European and Asian Russians.) The population of the central Asian republics is a mix of Kazahks, Russians, Germans, Ukrainians, Kyrgyz, Tajiks,Uzbeks, and Turkmen. In Transcaucasia, Armenia's population is mostly Armenian with Azeri, Kurd, and Russian minorities, while Azerbaijan is mostly Azeri with Russian and Armenian minorities. In Georgia, the population is mostly Georgian with other minorities.

Most Georgians and Armenians are Christian; Kazakhstan is a mix of Christians and Muslims; and the people of the remaining republics are mostly Muslim. Ethnic and religious conflicts, as well as conflicts over territory, have occurred in this region as late as the 1990s.

Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan all have languages of Turkic origin. The official languages of Armenia and Georgia are Armenian and Georgian, and the official language of Tajikistan is Tajik, a Persian (Iranian) language.

ECONOMY

Siberia in Asian Russia has a wealth of natural resources, including oil, natural gas, forest, and precious metals. In the past, forced labor and population resettlement to Siberia increased mining and industrial development where Siberians still remove gold, diamonds, gas, and oil from the frozen land today. In the warm climate of Transcaucasia, there are tropical fruits, cotton, tobacco, grain, and olives, as well as mineral resources.

DID YOU KNOW?

Russians built the Trans-Siberian Railway from 1891 to 1905 to encourage development in Siberia. The trip from Moscow to Vladivostok is 5,786 miles, takes seven days, and crosses seven time zones.

In the central Asian republics, there are coal deposits, oil, natural gas, and mineral resources. In the past, Soviet planners dictated industrial development of the area and invested in irrigation for the growth of cotton crops. While the area still

has oil refining, gas extraction, mining, and cotton as major industries, the Soviet's development plans have left many environmental problems, including the shrinking of the Aral Sea.

SOUTHWEST ASIA: THE MIDDLE EAST

Loosely defined, the term Middle East refers to the Arab countries east of the Mediterranean Sea and on the Arabian Peninsula, and includes Turkey and Cyprus and the countries of north Africa (discussed later in lesson about Africa). Characteristics of the Middle East include vast oil reserves, a desert environment, and the Islamic religion, which heavily influences life in much of the region. Bahrain, made up of 35 islands in the Persian Gulf, is the smallest country in the Asian part of the Middle East, and Saudi Arabia is the largest covering four-fifths of the Arabian Peninsula.

With the exception of coastal areas, most of the peninsula is flat desert. Iran and Turkey, however, are more mountainous. The Tigris-Euphrates River valley is fertile area in the Middle East's arid landscape. Most of the region receives less than 10 inches of rain a year, and there are frequent sandstorms.

An important waterway in this region is the Strait of Hormuz through which ships must pass to reach the oil terminals in the Persian Gulf. The strait was the location of international tension during the Iran-Iraq and Gulf Wars. Jutting into the strait is a peninsula belonging to Oman but separated from it by the United Arab Emirates. Another location of conflict in this region is Israel, a Jewish state in an Islamic world.

Important Middle Eastern cities include:

- Jerusalem on the border of Israel and the Israeli-occupied West Bank of Jordan, a holy city for Jews, Muslims, and Christians
- Jericho in the Israeli-occupied West Bank of Jordan, site of the world's oldest known settlement dating from 9000 B.C.
- Mecca, Saudi Arabia, the birthplace of Mohammed and Islam's holiest city, which is closed to non-Muslims
- Istanbul, Turkey, formerly Constantinople, the only city in the world on two continents.

PEOPLE

A majority of Middle Easterner's are Arabic-speaking Muslim Arabs. Exceptions include:

- Sizable Christian populations in Cyprus and Lebanon, and a Jewish majority in Israel
- Turkish and Greek spoken in Cyprus, Turkish spoken in Turkey, Farsi (Persian) spoken in Iran, Hebrew spoken in Israel
- A Persian (Iranian) majority in Iran, a Turkish majority in Turkey, and large Kurdish minorities in Iraq and Turkey. The Kurds are the largest ethnic group in the world without their own state. Often politically oppressed and persecuted, they fight and negotiate for an independent Kurdish state.

Many problems in the Middle East have occurred because of these ethnic and religious differences. In Cyprus, the Turkish part of the island declared independence in 1983. In Lebanon, a civil war between Christians and Muslims started in 1975 and lasted almost 15 years. After World War I, Palestine (a holy land for Jews, Muslims,

and Christians) came under British supervision. After World War II, most of Palestine became the Jewish homeland of Israel, and Arabs living in Palestine, or Palestinians, became refugees in neighboring countries. In the Arab-Israeli War of 1967, Israel occupied and held the remaining Palestinian territory belonging to Egypt (Gaza Strip), Syria (Golan Heights), and Jordan (West Bank). As of 1999, although negotiations for a peaceful solution are ongoing, animosity between Israelis and Palestinians continues in the form of terrorist and retaliatory activities.

ECONOMY

Many countries in the Middle East have economies based on oil production, making them some of the world's richest countries. Bahrain is a major center for oil trading, banking, and commerce. Iraq and Iran are two of the world's largest producers of oil, but recent wars have disrupted production. Oil provides 95 percent of Kuwait's government revenue and 90 percent of Oman's. Qatar's off-shore oil makes up an eighth of the world's known reserves; reserves in Saudi Arabia, the world's leading oil exporter, account for a fourth of the world's known oil supply. Syria and the United Arab Emirates also have economies based on oil. To avoid relying too heavily on oil income, Kuwait, Oman, and Saudi Arabia, are attempting to diversify their economies.

In the remaining countries, light manufacturing and agriculture are major economic activities. Tourism is important in Cyprus, Israel, and Turkey. Lebanon, once a commercial and financial center, is attempting to revive its economy devastated by civil war.

SOUTH ASIA: THE TRIANGULAR SUBCONTINENT

The countries of south Asia are on or near the triangular peninsula known as the Indian subcontinent (Illustration 5.5.5). Characteristics of this region include thousands of small villages, as well as large, overpopulated cities, much poverty and underdevelopment, and intense faith in various religions. Mountains outline the region. The Hindu Kush, Karakoram, and Himalayas in the north spread across Afghanistan, Bhutan, Nepal, and part of Pakistan and India. The much smaller mountains of the Western and Eastern Ghats ranges dot the southwest and southeast coasts of India, with the Deccan Plateau, noted for its cotton, lying between them.

The Thar Desert covers 125,000 square miles in northwest India and east Pakistan. In the mostly desert country of Pakistan, the Indus River helps irrigate crops. Crossed by the Brahmaputra and Ganges Rivers, Bangladesh, which is flat and low-lying, is subject to frequent flooding. The Maldives are also low-lying, and only 202 of its 1,190 islands have inhabitants.

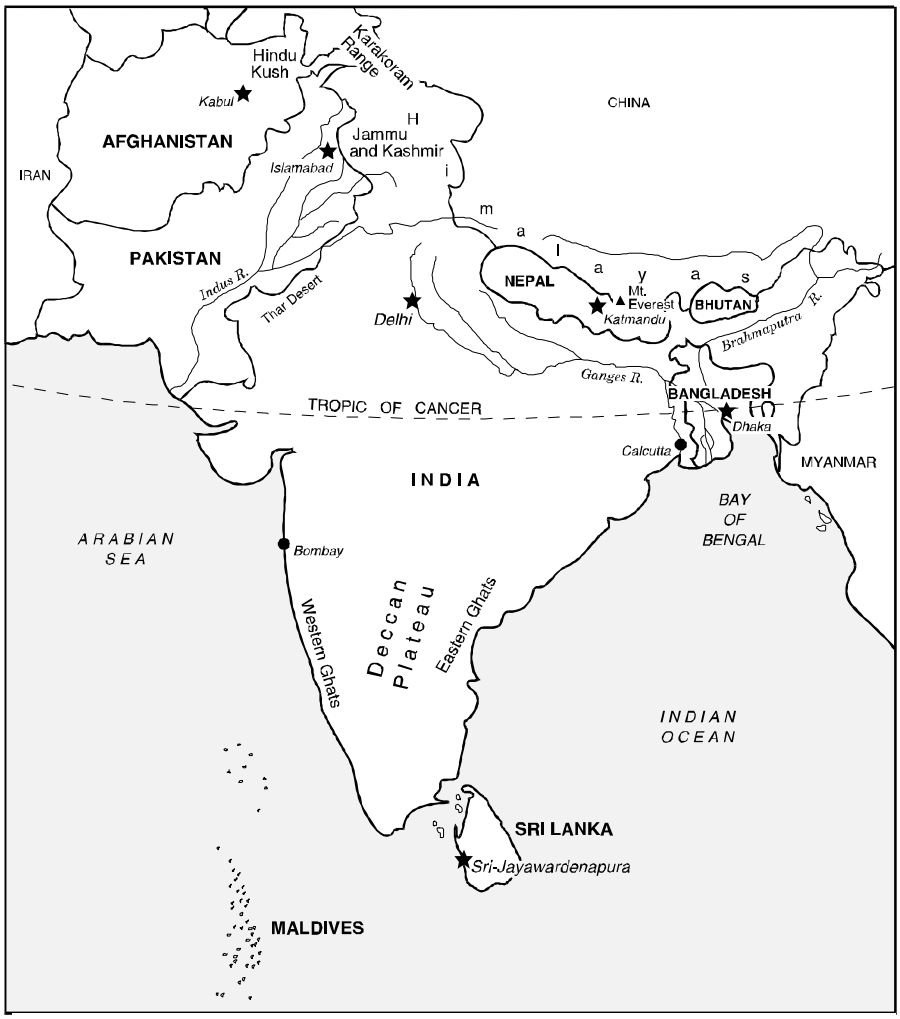


Illustration 5.5.5 — South Asia

PEOPLE

More than one billion people live in South Asia, which has the world's second largest population cluster. India's population of 890 million is greater than that of Europe, the Middle East, and northern Africa combined. In Bangladesh, more than 120 million people live in an area the size of Iowa, which, by comparison, has less than 3 million inhabitants.

Many of the people on the Indian subcontinent are of Dravidian and/or Aryan descent. The Dravidians were original inhabitants of the region, and the Aryans were invaders. Most people of Dravidian origin live in south India and Sri Lanka. People of Aryan descent live in northern India, Pakistan, the Maldives, and Sri Lanka. The Nepalese of Nepal are a mix of Aryan and Mongolian blood.

Many of the languages spoken are Indo-Aryan. They include, among others, Hindi, Bengali, Nepali, and Sinhalese. Afghanistan's official languages are Iranian-related, and Bhutan's is a variant of Tibetan. Since much of this region was once a British colony, English is also widely spoken here.

Islam is the major religion in Afghanistan, Bangladesh, the Maldives, and Pakistan. There are **Buddhist** majorities in Bhutan and Sri Lanka, and Hindu majorities in India and Nepal. Racial and religious hostilities exist between Hindu and Muslim animosity in Kashmir (officially Jammu and Kashmir), an Indian-administered state claimed by both Pakistan and India.

ECONOMY

As previously indicated, south Asia is a very crowded part of the world, and innovations in health and medicine continue to increase population growth. The amount of cultivated land per person continues to decline. Farming methods are inefficient, and there are food shortages. Many people in this underdeveloped region live in hunger and poverty.

Agriculture is the main economic activity in south Asia, in some countries employing as much as 90 percent of the population. Rice is an important food crop, growing well in south Asia's famous **monsoon** climate. Other crops include wheat, sugarcane, coffee, tea, spices, corn, and jute, a native south Asian plant with fibers used in burlap, sacking, twine, rope, and insulation.

Manufacturing of textiles, especially cotton products, is important in this region. In India, industrial production has increased considerably since independence, and tourism is expanding in the Himalayan countries.

SOUTHEAST ASIA: PENINSULAS AND ISLANDS

Southeast Asia (Illustration 5.5.6) is a region fragmented into peninsulas and islands. Indonesia is the region's largest country and the world's greatest archipelago, made up of more than 13,000 islands and stretching for almost 3,500 miles. Over 6,000 of these islands have inhabitants. The main islands are Sumatra, Java, Sulawesi, the western part of New Guinea called Irian Jaya (the eastern part, Papua New Guinea, is considered part of Oceania), and the southern part of Borneo (Kalimantan). The northern part of Borneo mostly belongs to Malaysia except for the small country of Brunei, an Islamic **sultanate** far from the Middle East. The Philippines is also a country of islands — more than 7,100. The Malay Peninsula forms part of Thailand and Malaysia, with the island country of Singapore at its southern tip. Important rivers cross the region's mainland countries: the Ayeyarwady (formerly Irrawaddy), the Mekong, and the Red. Many people in this region live in the valleys surrounding these rivers. Mountains and thick tropical forests cover much of the rest of southeast Asia making human settlement difficult. Many of Indonesia's peaks are actually volcanoes. Indonesia has 77 active volcanoes, more than any country in the world.

PEOPLE

In southeast Asia, the Burmans make up the majority of the population in Myanmar (formerly Burma), the Malays make up the majority in Brunei and Malaysia. Other people groups in the region include the following: the Khmer or Cambodians in

Cambodia; the Laotians (related to the Thai) in Laos; the Filipino in the Philippines; the Thai or Siamese in Thailand (formerly Siam); the Vietnamese in Vietnam; and the Chinese in Singapore. The Chinese also make up large minorities throughout the area. Indonesia is a mix of many ethnic groups.

Languages in the region include Burmese, Malay, Khmer, Bahasa Indonesian, Lao, Pilipino, Thai, and Vietnamese. In Singapore, the chief languages are English, Malay, Chinese, and Tamil. English and French are also widely spoken in many of these countries because of their colonial heritage, and Indonesia has more than 250 different languages spoken.

Indonesia and Brunei are predominantly Muslim; Myanmar, Laos, and Thailand are predominantly Buddhist; and the Philippines is 83 percent Roman Catholic. The populations of Malaysia, Singapore, and Vietnam practice several different religions. Buddhism was the chief religion in Cambodia until the Khmer Rouge (communist revolutionaries) outlawed religion in 1975.

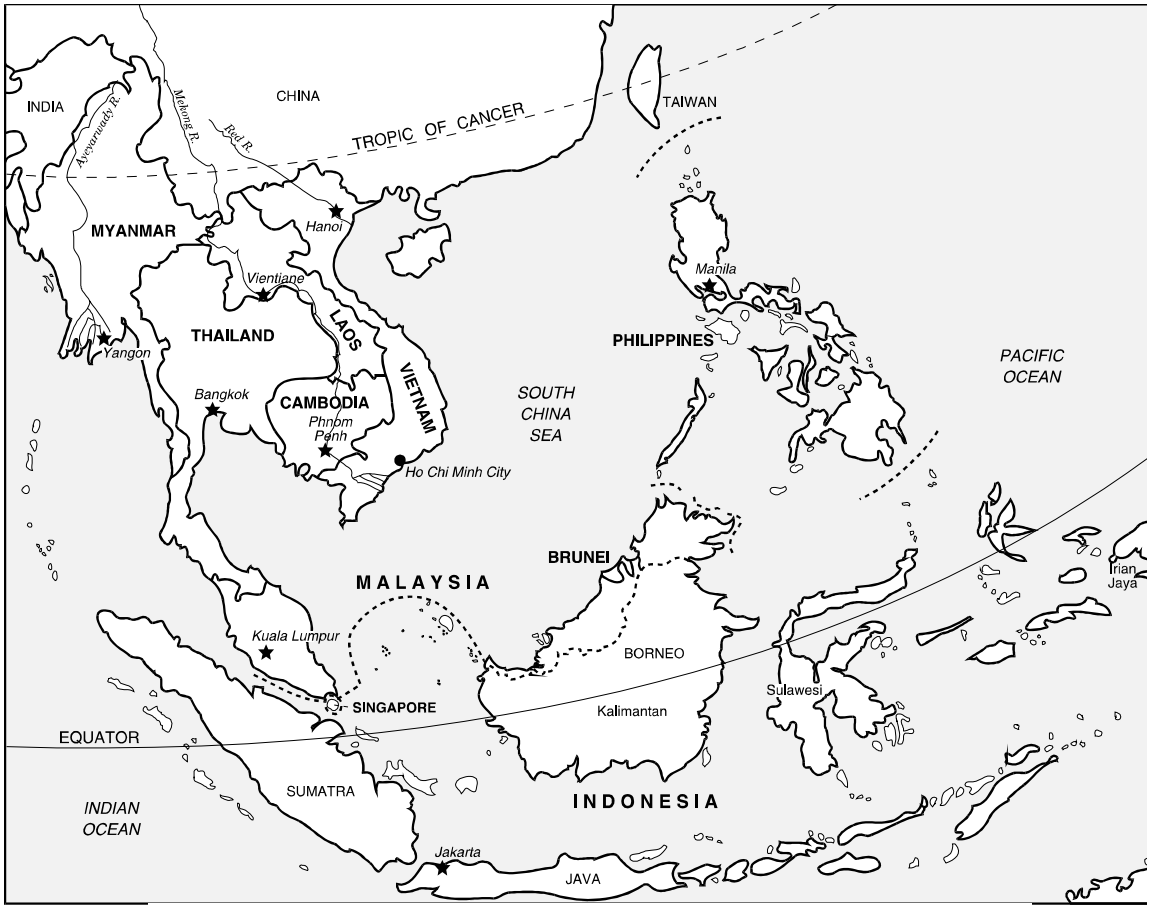


Illustration 5.5.6 — South Asia

ECONOMY

Southeast Asia is an underdeveloped region of the world. The economies in most of these countries depend largely on agriculture with rice, sugarcane, tobacco, and rubber as important crops. Java's rich volcanic soil makes it one of the most agriculturally productive places on Earth.

Brunei is a large oil producer, and oil and natural gas from Borneo and Sumatra account for 60 percent of Indonesia's income. Singapore, a major shipping center, is southeast Asia's most developed country. It has a diversified industrial economy with a well-educated workforce. In contrast, Laos has little industry, no railroads, few paved roads, and is this region's poorest country, and in many parts of the Philippines, major overpopulation contributes to poverty and malnutrition.

Considering southeast Asia's geography, fishing is also a profitable economic activity. Tourism is important in the more politically stable countries.

EASTERN ASIA: CHINA, JAPAN, AND NEIGHBORS

Territorially, China dominates eastern Asia (Illustration 5.5.7). Twenty-two provinces and five autonomous regions cover the country's 3,700,000 square miles. Tibet is home to the Plateau of Tibet and is known as the "roof of the world." It is an autonomous region, as is Inner Mongolia, an area of desert and semi-desert, are two of the autonomous regions. They are part of the western two-thirds of China, which is mountainous, sparsely populated, and arid. The remaining third of the country along the east coast is heavily populated, fertile, and flat.

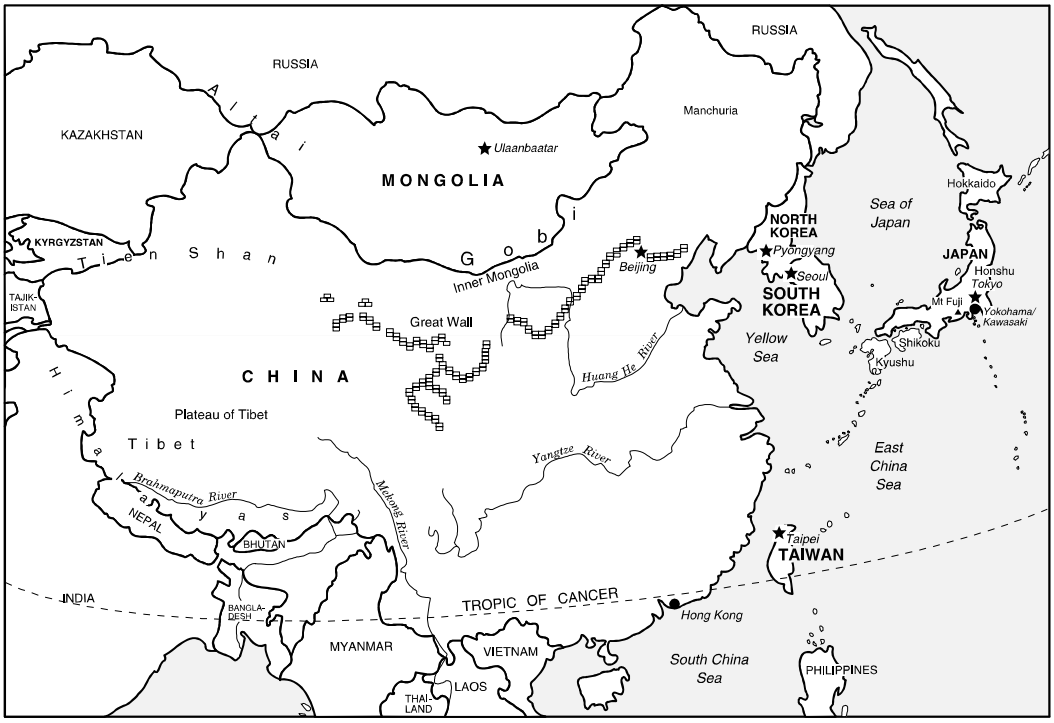


Illustration 5.5.7 — Eastern Asia

Mongolia, a large desert country, lies to China's north. Taiwan, an island of less than 14,000 square miles, lies 80 miles off the southeast coast of China. Taiwan is two-thirds mountains and crossed by the Tropic of Cancer. Japan is also an island country. Despite having a total area less than the size of California, Japan is politically and economically powerful. Its four largest islands are Hokkaido, Honshu, Kyushu, and Shikoku. The islands are mountainous with 54 active volcanoes.

DID YOU KNOW?

To combat overpopulation, China has a population policy that limits most families to only one child. Many Chinese understand their country's population problem and willingly comply with the policy.

To Japan's west on a peninsula bordering northeastern China are North (communist) and South (democratic) Korea. A 487 square mile demilitarized zone separates them from each other. South Korea has hot summers and cold winters, while the more mountainous North Korea experiences warm summers and severely cold winters. Typhoons, or hurricanes that form over the Pacific Ocean, bring heavy rains to Japan, Taiwan, South Korea, and southeast China in late summer and early fall.

DID YOU KNOW?

The Great Wall of China, built between 221 B.C. and the 1600s to repel invaders, is over 1,500 miles long and an average of 25 feet high and 12 feet wide.

IMPORTANT HISTORICAL/POLITICAL CONSIDERATIONS

The two political giants in east Asia are China and Japan. In fact, the remaining countries in the region have been under either Japanese or Chinese control, or both, at one time or another in their past. When the communist government took over China in 1949, the nationalist government moved to Taiwan and founded the Republic of China. Today, Taiwan continues to proclaim its independence from China, and China continues to claim Taiwan.

PEOPLE

With almost 1.2 billion people, China has the greatest population of any country in the world. By contrast, the United States, which is only slightly smaller in size than China, has only 252 million people. One out of every five people on Earth lives in China, most of them in the east.

For their size, Japan, South Korea, and Taiwan have some of the greatest population densities in the world. In contrast, Mongolia is the world's emptiest country with little over 2 million people spread out over 1.5 million square miles. Mongolia's population is 90 percent Mongol, descended from nomadic tribes in Mongolia and southern Siberia with a reputation for skilled warfare and horsemanship. Many Mongols also live in China's Inner Mongolia.

Mongolia's official language is Khalkha Mongol, and its chief religion is Buddhism.

The Chinese make up the majority of the populations in Taiwan and China, but China also has over 50 different minorities. Mandarin Chinese is the chief language in both countries, but China has many other dialects. Minority languages are spoken here as well. China is officially an **atheist** country, but many Chinese follow **Confucianism**, Buddhism, and Taoism (a philosophy and religion that teaches harmony between the individual and the natural world).

Despite the border that divides them, the people of North and South Korea have the same ancestry, language, religion, and until recently, history. Both countries have Korean majorities, and Korean is their official language. Buddhism and Confucianism, as well as Christianity, are some of the religions practiced in South Korea. Although Buddhism and Confucianism are also practiced in North Korea, religious activities there are minimal.

Japan's society is very different from the other countries in this region. It is both modern and traditional. With a population over 99 percent Japanese, it has few minorities and is one of the most **homogeneous** populations of its size in the world. Japanese is Japan's official language, and its chief religions are Buddhism and Shintoism, an ancient native religion that incorporates features of Buddhism and also involves reverence to Japanese ancestors.

ECONOMY

Japan is one of the world's industrial and technological giants. Since it has limited natural resources, it buys raw materials and sells finished products worldwide. These products include, among many others, electrical goods, electronics, automobiles, cameras, and film. The country also supplies engineering and financial services, as well as information technology. Agriculture in Japan is very efficient and productive, even though less than 20 percent of Japanese land is under cultivation. There is intensive crop production of rice, and other economic activities include timber and fishing.

Taiwan is another country that has few raw materials but is still very successful in manufacturing. Following Japan's lead, the country is now switching to high technology.

Unlike Japan and Taiwan, China is rich in natural resources. China's heavy industry produces iron, steel, coal, machinery, and armaments. More recently, the country is turning to light industry, like household goods, and is attempting to disperse factories and manufacturing into its interior. To feed its large population, China uses agricultural technology and diversifies crops to increase food production.

Regarding North and South Korea, most of the mineral wealth is in the north. South Korea, however, has one of the world's largest deposits of tungsten, a metal used in light bulb filaments and steel. North Korea is especially rich in iron and coal and has more heavy industry than South Korea. South Korea, which has a more rapidly growing economy, produces light consumer products but is shifting to heavy industry. Only about 20 percent of the total land in

both countries is good for agriculture, and fishing is an important economic activity.

Mongolia is the least industrialized country in this region and relies on raising livestock and processing animal products for its income. Some cultivation of its arid land is possible with irrigation.

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LESSON 6: AFRICA — THE PLATEAU CONTINENT

deforestation
desertification
famine
nomadic
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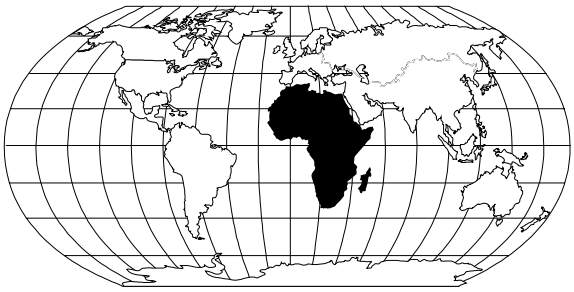
INTRODUCTION



Africa (Illustration 5.6.1) is the second largest continent. It is connected to the largest continent, Asia, by the Sinai Peninsula. With much of its land over 1000 feet in elevation, and few lowlands or mountainous areas, it is often called a plateau continent. In contrast to the Americas, Europe, and Asia, Africa is without a mountain range of continental proportions such as the North American Cordillera and Andes, Alpine, and Himalaya Mountain Systems.

Like South America, Africa extends about 5000 miles from north to south, but it is located farther north than South America. It is the only continent crossed by both tropics and the Equator. Because the Equator bisects it, Africa has similar climate and vegetation in its northern and southern halves. It is an excellent example of basic climate as discussed in the first lesson of this chapter. Africa is hot and rainy at the Equator with jungle vegetation. Moving away from the Equator, the land becomes a savanna with wet and dry seasons. At the tropics, are deserts and semi-deserts.

In the south where the Tropic of Capricorn crosses Africa are the Namib and Kalahari Deserts, and in the north where the Tropic of Cancer crosses Africa are the Libyan and Sahara Deserts. The Sahara, which is mostly a plateau between 500 and 2000 feet high, is the largest desert in the world extending 3000 miles east to west and 1200 miles north to south. Covered by areas of sand, rock, and gravel, the Sahara includes the Ahaggar and Tibesti Mountains and part of the Atlas Mountains. The Sahel south of the Sahara marks a zone between desert and savanna where rainfall is irregular and drought and **famine** often occur.

The three greatest rivers in Africa are the Nile, Zaire (formerly the Congo), and the Niger. The Nile is the longest river in the world flowing over 4,000 miles from the Equator north to the Mediterranean Sea. Its main trunk is formed by the joining of the Blue Nile and the White Nile. These flow from Lake Victoria, the largest lake in Africa at almost 27,000 square miles. Other large lakes include the following: Lake Chad at the meeting point of four countries — Chad, Niger, Nigeria, and Cameroon (Illustration 5.6.2); Lake Tanganyika, the second largest lake in Africa; and Lake Malawi, often called the Calendar Lake because it is 365 miles long and 52 miles across at its widest point.

Lakes Tanganyika and Malawi make up part of the Great Rift Valley in eastern Africa. A rift valley forms when parallel cracks occur in the Earth's crust and the land between them sinks. The deepest parts of the valley contain long, narrow lakes.

Illustration 5.6.1 — African Terrain

The eastern rift of Africa's Great Rift Valley includes the Red Sea, a trench cut through the Ethiopian Highlands into Kenya and Tanzania (Illustration 5.6.2), and Lake Turkana. The western rift runs down western Uganda, Rwanda, Burundi, and Tanzania, then through Malawi to southern Mozambique, and includes Lakes Tanganyika and Malawi. Lake Victoria lies between the eastern and western rifts but is not part of the Great Rift Valley.

IMPORTANT HISTORICAL/POLITICAL CONSIDERATIONS

As in Asia where great civilizations flourished along rivers, the ancient Egyptians

created a kingdom along the Nile about 5000 years ago. They developed a form of writing, built huge pyramids that still stand today, and made important contributions to art, astronomy, medicine, architecture, and geometry. After being conquered by the Greeks and Romans, among others, Egypt was conquered by the Arabs in 640 A.D. Eventually the Arabs extended their influence and Islam over the entire north coast of the continent, south into Sudan, and along the east coast. Meanwhile, several great African states developed, including Ghana, Mali, and Ethiopia.

In 1467, the Portuguese sailed around the Cape of Good Hope in search of eastern Asia. Soon, Europeans had set up stations and forts along Africa's west coast. By the 1800s, explorers had crossed the continent and the Suez Canal had been dug, dramatically shortening the shipping route from Europe to Africa's east coast. Competition among European powers for African territory grew fierce.

In 1884, a conference of 14 countries, including the U.S., met in Berlin to attempt to settle colonial rivalries. Even though 80 percent of Africa was still under African rule at the time, the entire continent was divided up among European colonial powers without regard to the physical or human landscape that already existed on the continent. The only two African countries that remained independent were Ethiopia, which fought successfully against the Italians, and Liberia, established in 1822 as a home for freed African-American slaves.

Since World War II, African countries have struggled for independence, most gaining it in the 1960s and 70s. Yet, as in other world regions with a history of colonial rule, the transition to independence has not been easy. Many ethnic and political conflicts have resulted, and the political boundaries of Africa are still in transition today. In addition, much of Africa is plagued by poverty, disease, inadequate healthcare, malnutrition, agricultural problems, and a high illiteracy rate. Despite an abundance of natural resources, its economic growth has been slow and its rapidly growing poulation is not adequately supported. Parts of Africa are some of the most underdeveloped areas on Earth.

REGIONS

When discussing regions, Africa is generally divided into North Africa (Illustration 5.6.2, Region 1) and sub-Saharan Africa (Illustration 5.6.2, Regions 2 to 5). North Africa's location historically and geographically has put it in contact with people from Europe and Asia. At the same time, the vast Sahara Desert buffered sub-Saharan Africa from these influences for centuries. In sub-Saharan Africa, most people are descendants of Nilotic (originating in the southwestern Ethiopian Highlands), Cushitic (originating in the Ethiopian Highlands), and Bantu (originating in eastern Nigeria) ancestors — considered Black Africans. These main groups are divided into hundreds of other ethnic groups, many of which have their own language and religion.

In North Africa, most people are descendants of Arab, Berber (believed to be the oldest inhabitants of North Africa having settled along the Mediterranean by 3000 B.C.), and Black African ancestors. Due to this Arab ancestry and to Arab rule for over a thousand years, North Africa is more closely associated with the Middle Eastern region of Asia than with the rest of Africa. There are also huge oil and natural gas reserves in North Africa, just as there are in the Middle East. These reserves, along with industrial development and stable. economies in most North African countries, make the region the most prosperous in Africa.

Illustration 5.6.2 — African Countries

In contrast, the countries of sub-Saharan Africa with little industry have weaker economies based mainly on subsistence farming and the exporting of raw materials. Also, compare the number of landlocked countries in sub-Saharan Africa with North Africa, which has no landlocked countries.

NORTH AFRICA: THE MOST PROSPEROUS REGION

People

The Sahara Desert covers most of North Africa and is sparsely populated. Small groups of people live around its **oases**, and **nomadic**

people travel across it in search of vegetation and water for their livestock. More and more, however, nomadic people are encouraged to settle in one place, so that governments have better control of them. Unfortunately, fragile lands which could recuperate when used in rotation, are often overused once they become a permanent settlement. In the semi-deserts along the Sahara's edges, the overuse of land and frequent droughts have resulted in **desertification**.

Most people in North Africa, however, live either in the Atlantic and Mediterranean coastal lowlands, in the Atlas Mountains (all of which receive adequate rainfall), or along the Nile River (the only large river providing water to the region). The Nile River basin is one of the most densely populated places on Earth and contains some of the most fertile land in the world. Lake Nasser, created on the Nile by the Aswan Dam, allows irrigation of many more millions of acres of farmland.

In Morocco, Algeria, and Tunisia, Arabs make up 70 percent or more of the population, with many Berbers living in the Atlas Moutains. Most Egyptians are a mixture of Arabs and descendants of ancient Egyptians, while most Libyans are a mixture of Berbers and Arabs. In Sudan, half the population is Arabic (mostly in the north) and the remaining half is Black African — mostly Nilotic, including the Dinka, Nuer, and Shilluk. There are also European minorities in the region traced to colonial times.

Regardless of background, most people in North Africa, like their Asian neighbors in the Middle East, speak Arabic and follow the Islamic religion, which is a major force in North African society and government. In addition to Arabic, many people also speak a European or African language.

Non-Muslim minorities include a 10 percent Christian population in Egypt. In Sudan's southern sections, 8 percent follow the Christian faith and 17 percent follow various African religions. Attempts by Sudan's government in the late 1980s to impose Islamic holy law on the non-Muslim south resulted in rebellion and a continuing civil war.

Economy

Economically, as already mentioned, North Africa is a prosperous region. Egypt, Libya, and Algeria are all major oil exporters, and Morocco, Tunisia, and Western Sahara (under Moroccan occupation) all have large supplies of phosphates, which are used in fertilizers. Other industry in the region produces iron, steel, chemicals, textiles, cement, and food products.

Morocco has strong fishing and tourism industries. Tourism is also important in Tunisia and Egypt. A great cultural, financial, and commercial center, Egypt is also politically the strongest country in the region and one of the strongest in the Middle East. Its capital, Cairo, is the largest African city, as well as one of the largest cities in the world.

Climate in the Atlas Mountains supports farming and livestock, and the Mediterranean climate along the Tunisian and Algerian coasts supports crops like grapes and olives. Egypt grows cotton, among other crops, and is famous for its cotton products.

Sudan is the poorest country in this region with most of the population employed in agriculture. Its economic development has been hindered by chronic civil war and major famines in the 1980s and 1990s.

SUB-SAHARAN AFRICA: FOUR VERY DIVERSE REGIONS

This section begins with a discussion of the people of sub-Saharan Africa, followed by

information about the physical geography and economies of each of its four regions. (**Note**: Refer back to Illustrations 5.6.1 and 5.6.2 while reading about each region.)

People

As previously mentioned, the majority of the people living in sub-Saharan Africa are Black Africans, yet there are hundreds of different ethnic groups within this classification, many with their own language and religion. The following lists some of these ethnic groups along with the region of sub-Saharan Africa in which they reside.

- East Africa — Oromo, Amhara, Somalis, Ganda, Maasai, Hutu, and Tutsi
- West Africa — Fulani, Hausa, Asante, Ewe, Mende, Bambara, Malinke, and Dogon
- Central Africa — Baya, Azande, Ovimbundu, Kongo, Tonga, Luba, Mbuti, and Fang
- Southern Africa — Sotho, Zulu, Swazi, Herero, Shona, Ndebele, Xhosa, and Ovambo

Minorities in sub-Saharan Africa include:

- In East Africa — Asians mainly from India; Europeans; and groups of mixed Black African, Arab, and Persian (Iranian) descent such as the Swahili.
- In West Africa — Moors of mixed Arab, Berber, and Black African descent who make up a majority of the population in Mauritania.
- In Southern Africa — Africaners of mixed Dutch, French, German, and Black African descent considered the "white" minority in South Africa; Cape Coloreds and Cape Malays of mixed European, Asian, and Black African descent; Madagascans of mixed Black African and southeast Asian descent; and Indians whose ancestors came to work on British plantations in the 1800s.

In addition to the hundreds of African languages related to particular ethnic groups, languages of former colonial powers are spoken in sub-Saharan Africa and are often recognized as the official languages of countries. A common language, usually a language used formerly for trading, may also be spoken throughout an entire region — for example, Swahili in East Africa, Arabic and Hausa in West Africa, and Shona in Southern Africa. For these reasons, many people in sub-Saharan Africa speak more than one language.

In addition to the many African religions related to particular ethnic groups, both Islam and Christianity are practiced in sub-Saharan Africa. Islam spread, of course, through contact with the Arabs and is followed mostly in the northern countries of East and West Africa, in the area often referred to as the transition zone between Arab North Africa and sub-Saharan Africa. Moving south away from North Africa are smaller percentages of people practicing Islam, with very few in Central or Southern Africa.

Christianity was brought to the continent by European missionaries and is widely practiced in Southern and Central Africa and in the southern countries of East and West Africa, with smaller percentages of practicing Christians in the countries approaching North Africa. In some cases, a mix of an African religion with Christianity or Islam is practiced.

East Africa

East Africa is Africa's most mountainous region, including its highest peak, Mount Kilimanjaro, and the Ethiopian Highlands. The region also includes the Somali Peninsula, or Horn of Africa, and many lakes and rivers that help feed the Nile. The Horn of Africa is

mostly semi-desert, while grassy plains, most above 600 feet in elevation, cover much of Tanzania, Uganda, and Kenya. These plains support Africa's famous herds of wildlife, and Tanzanian and Kenyan national parks and game reserves are major tourist destinations. Unfortunately, while the parks and reserves protect wildlife, many also exclude local people who once used the land to graze livestock.

East Africa is the poorest region in Africa. Except for diamonds in Tanzania and copper in Uganda, it has few mineral resources, and there is little industry for processing raw materials. In addition, ethnic and political conflicts have hurt the region's economy. Some of the most recent conflicts (as of the 1990s) include the civil war in which Eritrea separated from Ethiopia; the ethnic fighting between Hutus and Tutsis in Rwanda and Burundi; and fighting between clans in Somalia.

Most people in East Africa make a living by farming, many at a subsistence level. Since they are growing just enough to survive, it is devastating when crops are ruined due to insufficient rainfall. In the past, widespread famines have resulted. Export crops grown in the region, historically on the best land, include coffee, tea, tobacco, and cotton. Intensive farming and **deforestation** have further weakened the already fragile soil in much of the region.

West Africa

For centuries, the West African coast was an important trade route, supplying ivory, gold, and slaves for American plantations. In addition to trade, colonialism brought export crops and urbanization to the coast, while much of the interior remained untouched. It also led to political and ethnic strife once colonial powers withdrew. In Nigeria and Chad, as in Sudan, there have been conflicts between the Muslim northerners and southerners who are mainly Christians or followers of an African religion. Civil wars as recent as the 1990s have occurred in Sierra Leone and Liberia.

Like North Africa, much of West Africa is plateau. The eastern boundary of West Africa is the Adamawa Highlands, partly created by molten rocks from volcanoes in the area. This volcanic soil provides fertile farmland in Cameroon. In contrast, the southern reaches of the Sahara, as well as the Sahel, lie in West Africa's northernmost land.

In the Sahel, desertification in certain regions has resulted from droughts and overuse of the fragile land. Nomadic peoples have been encouraged to remain in one place resulting in populations too large to be supported by the land. Droughts in the latter part of the twentieth century have severely affected crops and brought great hardship to populations in Niger, Mali, Mauritania, and Chad. Understandably, most people live in the southern half of the region along coastlines and rivers. In fact, about one-third of Africa's total population lives in West Africa — most in Nigeria.

While many West Africans are employed in subsistence agriculture, crops grown for export include cocoa, coffee, peanuts, and timber. Irrigation of land comes from rivers like the Niger, the largest in the region, Gambia, and Senegal, and from lakes like Chad and Volta. Volta is an artificial lake formed by the Akosombo Dam. These rivers also provide transportation for goods and people, and the rivers, lakes, and coastlines support fishing.

Unlike East Africa, West Africa possesses many mineral resources, including gold, diamonds, oil, natural gas, phosphates, and bauxite. Although Nigeria is oil-rich, it is deeply in debt, and its people have a very low

per capita income. The region is slightly more industrialized than East Africa.

Central Africa

The Zaire River basin covers much of Central Africa. To the basin's north in the Central African Republic and its south in Angola and Zambia are highland areas, with a thin strip of coastal lowlands in the west and the Great Rift Valley as a border in the east. With the Equator running through it, this region gets heavy rain and is very hot. Some of the low-lying areas are swampy, breeding mosquitoes and flies that spread dangerous diseases. This region is also the most heavily forested in Africa, supporting a productive timber industry that has also led to deforestation in some areas.

Central Africa is rich in mineral resources such as diamonds, copper, iron, oil, and manganese. Some countries like Gabon, Zaire, and Congo are more industrialized than their neighbors, yet still over half the population exists on subsistence farming. In Zaire, which has territory deep in the African interior, the economy is hindered because of poor transportation systems through the difficult vegetation and along the Zaire River, which has many rapids. Zambia, a landlocked country, is hurt by transportation costs associated with the long distance to a coastline. Central Africa's economy has also been hindered by a lengthy civil war in Angola and other conflicts in the region.

While Africa, in general, has one of the world's largest refugee populations, Central Africa, in particular, has huge refugee populations — both from people fleeing from one country to another within the region, as well as from people in surrounding regions seeking haven there. In the 1990s, Zaire accepted over one million refugees from Rwanda alone because of fighting in that country. Problems associated with refugee populations include lost labor and income for the country losing the refugees and unemployment for the country gaining them. Political conflicts often erupt between the countries. Furthermore, the large concentrations of people in a particular area can lead to environmental problems.

Southern Africa

Much of Southern Africa's interior is a plateau surrounded by mountainous highlands, including the Drakensburg. These highlands drop off steeply to narrow coastal lowlands in the west and south and to a wider coastal plain in the east, especially in southern Mozambique. Rivers in the region cannot be used by ships because of their many waterfalls. The highlands are sparsely populated, as are Botswana and Namibia, covered by the Kalahari and Namib Deserts. As with the Sahara, desertification has occurred along the fringes of these two deserts.

The country of South Africa dominates this region. Considered the most developed and wealthiest country on the continent, it boasts the richest gold mine in the world. Here also are diamond and coal mines, fertile farmland, large cities, transportation networks, factories, and ports. Most of the wealth, however, is held by a small, white minority and was earned over years of racial segregation and inequality.

South Africa's policy of *apartheid* (an Afrikaans word meaning separateness), forced ethnic groups to live in ethnic-specific "homelands" consisting of the least desirable land, and denied them the rights to vote, to an adequate education, and to work as a skilled professional — which forced them into employment on white-owned farms and mines. In addition, South Africa interfered in the government of neighboring countries by supporting rebel forces and white-minority rule

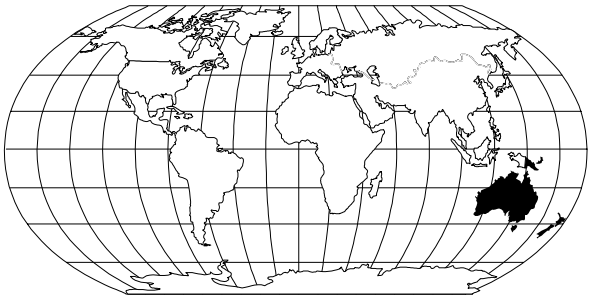
and even occupying Namibia in an attempt to preserve its own policies.

Many countries throughout the world cut political and economic ties with South Africa because of *apartheid*, which was finally abolished in 1991 after years of internal and external opposition. Still, the effects of *apartheid*, such as inequalities in wealth, ownership, education, etc., will not be easily overcome.

Many people in this region are employed by agriculture, and there are a wide variety of export crops including wheat, apples, cotton, and citrus. In Madagascar and Mozambique, however, subsistence farming is prevalent, and these countries are some of the poorest in the world. Madagascar's growing population and deforestation threatens the island's unique plant and animal life, while Mozambique's economy has been hindered by civil war and drought.

Many of the remaining countries are rich in mineral wealth, Accordingly part of the population is employed in mining. The economies of Botswana, Swaziland, and Lesotho are tied to South Africa, with many people employed as laborers on farms and in mines in that country. Botswana, which has the richest diamond mine in the world, and Zimbabwe are two of the most stable countries in the region.

LESSON 7: AUSTRALIA AND THE REST OF OCEANIA



In addition to Australia, Oceania consists of about 25,000 islands divided into three broad geographic-cultural areas — Micronesia, Melanesia, and Polynesia — each made up of several island countries, most of which are groups of many small islands.

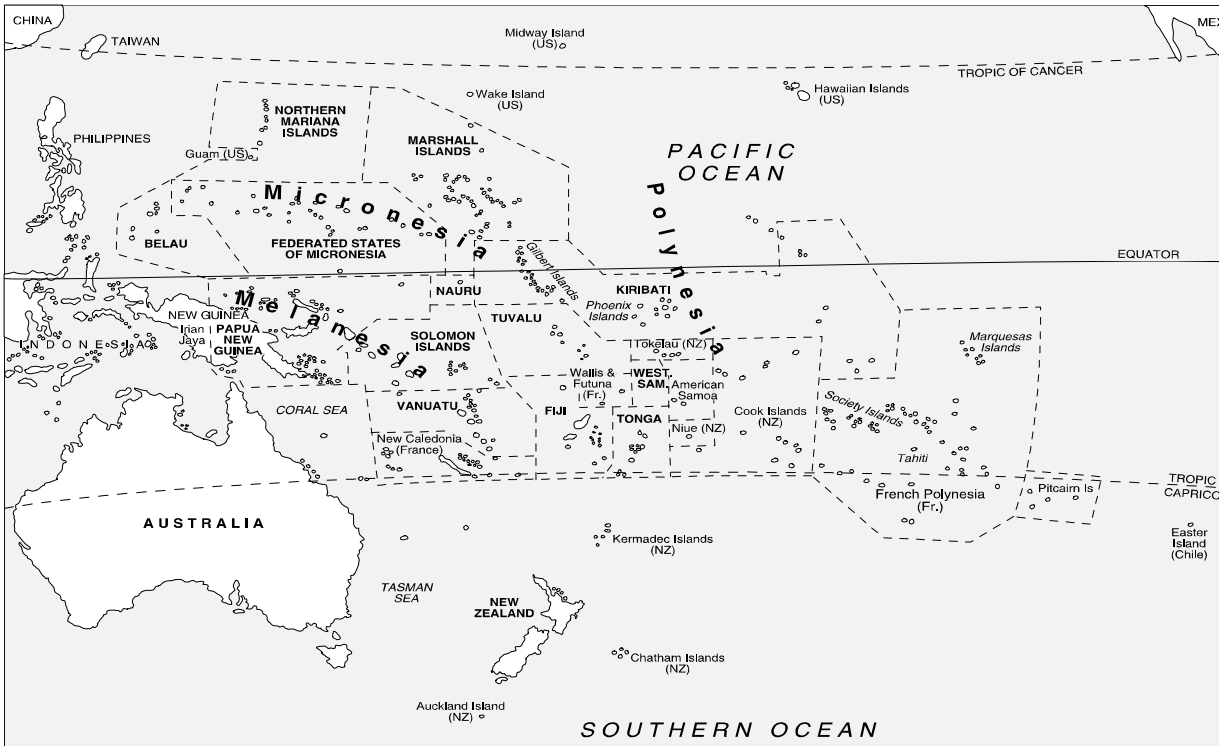


Illustration 5.7.1 — Oceania

INTRODUCTION

Collectively, the islands located in the Pacific Ocean away from the Asian continent are known as Oceania (Illustration 5.7.1). Unlike the islands previously discussed in this text, these islands (with the exception of Australia which is itself a continent) are not considered part of any continent.

AUSTRALIA: THE ISLAND CONTINENT

Australia (Illustration 5.7.2) is the smallest continent and the only continent that is also a single country. Situated south of the Equator, it is nicknamed “the land down under”. Australia is completely separated by water from any other continent, which led to another nickname “the island continent.” Because it is an island, Australia has unique

plant and animal life, including the kangaroo, wallaby, wombat, and koala.

In general, Australia is flat, consisting mainly of plains and plateaus. It has the lowest average elevation of any of the continents. It is also dry — note the continent's location in relation to the Tropic of Capricorn — and much of the plateau land is desert including the Great Sandy, Gibson, Great Victoria, and Simpson Deserts. In fact, desert and semi-desert areas in western and central Australia cover about two-thirds of the entire continent and are known as the Outback. While about 25 percent of the continent's land is unusable for agricultural purposes, the semi-desert areas support huge sheep and cattle ranches.

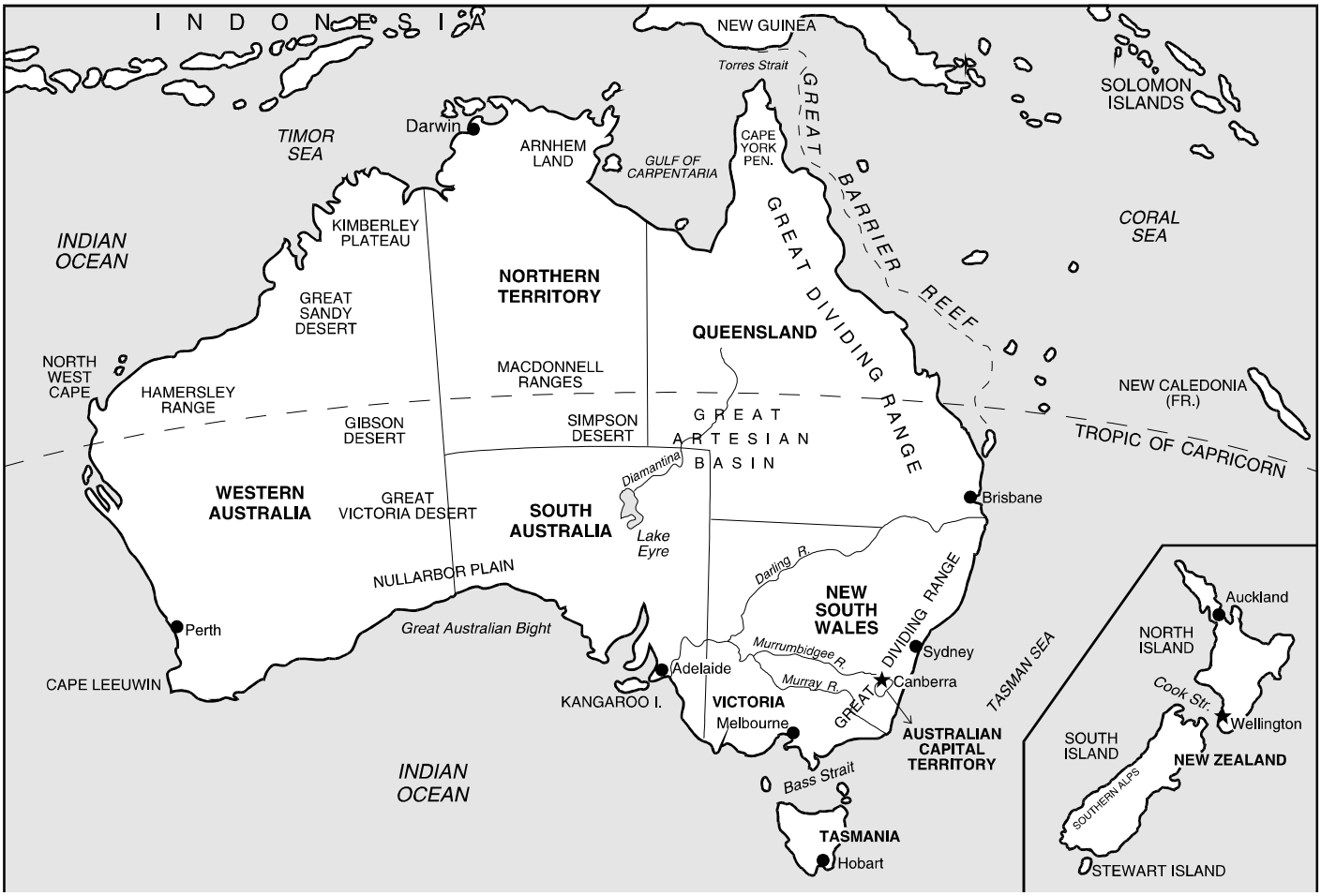


Illustration 5.7.2 — Australia and New Zealand

Between the desert plateau in central Australia and the Great Dividing Range (a highland area that parallels the east coast from Cape York in the north to the island of Tasmania in the south) is a lowland area covered by grassy plains that support livestock grazing. Between the Great Dividing Range and the sea as well as in the Murray River basin in the southeast are fertile lowlands that receive reliable rainfall and support huge commercial wheat farms, as well as livestock. A small piece of the southwest coast around the city of Perth also receives adequate rainfall providing for agriculture.

Off the east coast in the Coral Sea is the Great Barrier Reef. This area of coral is over 1240 miles long and is the largest known accumulation of coral in the world. Hence, it is a major tourist attraction.

IMPORTANT HISTORICAL/POLITICAL CONSIDERATIONS

Australia's original inhabitants were Aborigines arriving from southeast Asia about 40,000 years ago. European explorers landed on the continent in the 1600s. Great Britain claimed it in 1770, establishing New South Wales as a prison colony and sending shiploads of convicts there. Free settlers came to the continent looking for economic opportunities, especially after the discovery of gold, and the last convict ship arrived in 1849. Meanwhile, the Aborigine population began to decrease significantly, mostly because of European diseases.

Like Canada, Australia is a self-governing dominion within the British Commonwealth of Nations. It consists of six states (New South Wales, Victoria, Queensland, Western Australia, South Australia, and Tasmania) and two territories (Northern Territory and the Australian Capital Territory, where the nation's capital, Canberra, is located).

PEOPLE

Australia's immigration policy from the early 1900s to the 1960s excluded non-Europeans from migrating to the country and was specifically aimed at keeping out Asians, people from other islands in Oceania, and Africans. International pressure stopped this unofficial "white-only" policy. Yet, for labor reasons, Australian immigration policy remains selective, ensuring immigrants are skilled workers with job opportunities waiting for them. Because of this former policy and Australia's colonial history, most Australians are of European descent — particularly British. Asians make up four percent of the population, and Aborigines make up one percent. Most people speak English and follow a Christian religion.

Like Canada, Australia has a small population for its great size — it is the sixth largest country in the world. About 85 percent of Australians live in towns and cities along the east coast from Brisbane to Adelaide and in the southwest around Perth.

ECONOMY

Australia is a modernized, rich country, and its people enjoy a high living standard. It is the world's largest wool producer, a major exporter of beef, and a large exporter of wheat, sugar, fruit, and dairy products. It has an abundance of minerals including coal, bauxite, iron, nickel, lead, zinc, and uranium, as well as petroleum and natural gas reserves.

Australia's diverse manufacturing produces machinery, equipment, textiles, and food products. Manufacturing is limited, however, owing to the continent's small domestic market and the long distances to foreign markets.

NEW ZEALAND

Because of its original inhabitants, New Zealand (Illustration 5.7.2) is considered part of Polynesia. Nevertheless, because of its location and cultural ties to Great Britain, today it is more closely associated with Australia. New Zealand was originally settled by Maoris, a Polynesian people probably from the Marquesas Islands. Like Australia, it was claimed by Great Britain and today is a self-governing dominion within the British Commonwealth. Most New Zealanders are of British descent, speak English, and are Christian. Nine percent of the population is Maori, many of whom speak the Maori language.

Unlike Australia, New Zealand is mostly mountainous. North Island has hot springs and volcanoes, while South Island has glaciers and fjords. New Zealand is sparsely populated with more people living on North Island and one-third of the total population living in or around Auckland.

Like Australians, most New Zealanders have high standards of living. The economy is based mainly on agriculture, and New Zealand is a major dairy and wool exporter. It has coal and natural gas reserves, and its natural beauty supports a growing tourism market. It has a diverse manufacturing sector, yet is limited for the same reasons as Australia.

THE REST OF OCEANIA

As previously mentioned, the islands of Oceania, with the exception of Australia, are grouped for geographic and cultural reasons into Micronesia, Melanesia, and Polynesia (Illustration 5.7.1). In general, Polynesia forms a triangle in the eastern Pacific extending from the Hawaiian Islands in the north to New Zealand and Easter Island in the south. In the western Pacific, excluding those islands considered part of Asia, Micronesia includes the islands north of the Equator, and Melanesia includes the islands south of the Equator.

Note that the island of New Guinea, which is often included geographically in its entirety as part of Oceania, is split for political reasons. The western half, Irian Jaya, is part of Indonesia and, therefore, considered part of southeast Asia. The eastern half, Papua New Guinea, is a member of the British Commonwealth and is considered part of Melanesia.

PEOPLE

The people of the three regions, known ethnically as Micronesians, Melanesians, and Polynesians, are distinguished by physical appearance, blood type, language, social organization, and even art and housing. Yet, because of the fragmentation of land throughout Oceania, there are hundreds of languages spoken and a diversity of cultural traits. Of the three groups, Polynesian culture seems to be the most consistent from island to island. There are also European, Asian, and groups of mixed minorities scattered throughout these islands.

In Hawaii, there is a large minority of Japanese descent, as well as many Americans from the mainland U.S., and U.S. culture predominates. Like New Zealand's association with Australia, the Hawaiian Islands, while Polynesian, are now more closely associated with the U.S.

In addition to the many ethnic-specific languages spoken, English is widely spoken and used as a mutually understandable language throughout Oceania. French is also spoken in French Polynesia, Vanuatu, and New Caledonia. Christian religions are widely practiced throughout the three regions, in addition to island-specific and ethnic-specific religions.

IMPORTANT HISTORICAL/POLITICAL CONSIDERATIONS

In the past century, most of the islands have been under the protection of or administered by another country for some period of time. In fact, most of the island countries of Micronesia were administered by the U.S. as United Nations Trust Territories until they made the transition to self-rule. Those islands that remain politically part of another country are indicated on Illustration 5.7.1 by the initials or name of the associated country in parentheses.

ECONOMY

The main economic activities on most of these islands are agriculture and fishing, depending in part on the physical characteristics of the island itself. Those islands that are mountainous and volcanic have fertile soil that supports agriculture. Smaller, low-lying, coral islands tend to have poor soil, requiring people to look to the sea for their livelihood. In general, Melanesia has larger, volcanic islands, while a majority of Micronesian and Polynesian islands are smaller, coral islands. Trading for food between the people of the two types of islands is common. The Polynesians, in particular, are renowned as great maritime peoples who have traveled hundreds of miles across the ocean to fish and trade.

While many people practice subsistence agriculture, one of the most important export crops is copra, the kernel of the coconut from which coconut oil is extracted. Other exports include tropical fruit, cotton, sugarcane, fish, and handicrafts of the native people. In Melanesia, timber is an important resource. Other resources are sparse on most of the islands — a few exceptions include phosphate in Nauru; copper, gold, and petroleum in Papua New Guinea; gold in Fiji; and nickel in New Caledonia. Island countries also earn income by selling other countries fishing rights to their waters. Tourism is an important economic activity, particularly in Polynesia.

CONCLUSION

This unit provided you with an overview of world geography within the familiar framework of continents and countries. It discussed aspects of both the physical and human landscapes that make up our world and demonstrated how places can be grouped into regions based on common characteristics. This basic insight and background into world geography is an important skill to possess in today's age of information, global economics, and accessible worldwide travel. As a citizen of a leading world power, it will help you understand events around the globe — economic crises, political and ethnic conflicts, natural disasters, etc. — and how they can impact your country and, in some cases, your own life.

* * *

ENVIRONMENTAL AWARENESS

LESSON 1-2: ENVIRONMENTAL ISSUES

PURPOSE

Most of us take for granted our existence on this earth — the air we breathe, the water we drink, and the land upon which we live, work, and play. We do not stop to think about why the air and water are relatively clean and the land is relatively free from **pollution**. This chapter will help you to become more sensitive to environmental issues, thoughtful in your actions, and aware of the contributions that you can make to help protect your environment.

air emissions
ash
combustion
composting
incineration
landfill
leachate
liners
methane
pelletize
pollutants
pollution
recycling
searing
solid waste
source reduction
synthetic
toxicity

INTRODUCTION

Most Americans are not aware of decisions that governmental agencies and/or state and federal legislatures make to ensure the purity of our environment or to protect our health — that is, until it affects them directly. Even though environmental issues are often very diverse and technical in nature, many non-technical community leaders and citizens are making the decisions on these issues. Consequently, society is forcing these decision makers to gain a significant understanding of the technology, terminology, and laws governing environmental issues.

After completing this chapter, you should have a better appreciation for the environment around you; know how to safeguard its upkeep; and be prepared to prevent its breakdown.

BACKGROUND: EXAMPLES OF ENVIRONMENTAL IMPACTS

More than a century of advanced technology has taken its toll on the natural environment of North America. For decades, the federal government ignored the growing problems of water and air pollution. A public outcry during the 1960s, however, forced the government to establish the Environmental Protection Agency (EPA) and to take a leading role in enforcing new pro-environmental legislation. The presidential and congressional administrations of the 1970s made substantial progress on environmental issues until the public criticized them again in the 1980s for weakening the federal enforcement structure.

To introduce the complexity of this subject, listed below are three examples of environmental impacts on today's society.

- Various medical geographers and scientists now relate many forms of cancer, especially lung cancer, to environmental conditions. As a result of an intensified effort to study this finding, these experts have discovered that the distribution of respiratory-system cancers in the United States coincides with a number of major manufacturing and refining centers.

- Acid rain is a serious water pollution problem. The region surrounding the United States Manufacturing Belt (particularly Ohio, Illinois, Indiana, and Michigan — which produce about 75 percent of North America's sulfur and nitrogen emissions), is one of the areas worst affected by acid rain.

- Smog is an example of a severe air pollution problem that faces the large metropolitan areas in the United States. Air pollution is the presence of "unwanted material" (substances that are in sufficient concentrations to interfere with a person's health, comfort, welfare, or their enjoyment of property) in the air in excess of certain standards.

  Dozens of major cities experience this hazard, with Los Angeles and Denver among the most frequently exposed. Smog (a contraction of the words "smoke" and "fog") occurs when the warmer atmospheric air prevents cooler surface air from rising, thereby causing the surface air to become stagnant. The stagnant air then traps automobile and industrial emissions, thus intensifying the air pollution.

TYPES OF WASTE MATERIAL

Before discussing the key technological issues of **solid waste** and its disposal, an introduction is in order on the types of wastes and disposal facilities, as well as the different disposal procedures. Listed below are the major categories of wastes that communities must pick-up, transport, process, landfill, and/or take appropriate measures for disposal.

Domestic or Household Waste. Solid waste, comprised of garbage and rubbish, that normally originates in the household.

Garbage. Solid waste that consists of *putrescible* (defined on the next page) animal and vegetable waste materials, resulting from the handling, preparation, cooking, and consumption of food. It also includes waste materials from markets, and storage facilities, as well as the handling and sale of produce and other food products.

Hazardous Waste. Waste that because of its quantity; concentration; or physical, chemical, and/or infectious characteristics may pose a substantial hazard to human health or to the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Inorganic Waste. Non-combustible waste material made from substances composed of matter other than plant, animal, or

certain chemical compounds of carbon (for example, metals and glass).

Municipal Solid Waste. Waste that includes non-hazardous material generated in households, commercial and business establishments, and institutions. It excludes industrial-process, demolition, agricultural, and mining wastes; abandoned automobiles; ashes; street sweepings; and sewage sludge.

Organic Waste. Waste material that consists of substances composed of carbon and hydrogen compounds that are generally manufactured in the life processes of plants and animals. It includes paper, wood, food wastes, plastics, and yard wastes.

Putrescible Waste. Decaying solid wastes that can decompose rapidly causing foul odors and possibly attracting animals and/or disease carrying insects.

Residential Waste. Waste material generated in houses and apartments. It includes paper, cardboard, beverage and food cans, plastics, food wastes, glass containers, old clothes, garden wastes, etc.

Solid Waste. Garbage, refuse, sludges, and other discarded solid materials including those from industrial, commercial, and agricultural operations, and from community activities. It does not include solids or dissolved materials in domestic sewage or other significant **pollutants** in water resources, such as silt.

TYPES OF DISPOSAL FACILITIES AND PROCEDURES

Collection is the service of picking up and moving solid waste from its location of generation to a disposal area or facility, such as a transfer station, resource recovery facility, or **landfill**. Most disposal facilities have the necessary equipment and required land area to receive and dispose of wastes. These facilities may operate one or more disposal methods.

A sanitary landfill is just one method of disposing refuse on land without creating nuisances or hazards to public health or safety. Communities must ensure careful preparation of the fill area and control of water drainage to assure proper landfilling. To confine the refuse to the smallest practical area and reduce it to the smallest practical volume, facilities use heavy tractor-like equipment. This equipment spreads, compacts, and usually covers the waste daily with at least six inches of compacted soil.

The modern, properly engineered sanitary landfills have compacted clay or artificial (plastic) **liners**, **leachate** collection systems (which remove the leachate for

treatment and disposal), and/or systems to collect and remove **methane** gas generated in the landfill.

These modern facilities also use volume reduction to decrease the amount of space the waste materials occupy. Such facilities use three major processes to accomplish volume reduction.

- Mechanical Process — Uses compacting techniques (baling, sanitary landfills, etc.) and shredding.
- Thermal Process – Uses heating techniques (**incineration**) and can reduce volume by 80 to 90 percent.
- Biological Process — Uses bacterial action (**composting**, etc.) to degrade the organic waste.

SOLID WASTE ISSUES

EFFECT ON WATER SUPPLY

In the past, communities used unlined landfills that allowed for the contamination of groundwater — a source of drinking water in some areas. This exposure of small quantities of chemical waste leaching into an unfiltered groundwater supply can result in human health risks.

Today, communities operate state-of-the-art structures (sanitary landfills) to limit water pollution through the use of **synthetic** liners that guide the wastewater to a separate treatment system. To assist communities in these efforts and reduce the number of contaminated sites, the U.S. Congress passed the *Comprehensive Environmental Response, Compensation and Liability Act*. This law imposes strict liability measures for hazardous waste pollution and creates a "superfund" of money to clean up the worst hazardous waste sites across the country.

Other landfill problems facing communities are cost, intolerance, and odor. First, it is very costly and difficult for communities to close a landfill that is at its capacity or to site a new landfill. There are also costs associated with transporting the solid waste to another facility.

Intolerance can become a major problem when citing new landfills because of the "Not In My Back Yard," or NIMBY, concept. Most of us want trash picked up on time, but once collectors pick it up, it is "out of sight and out of mind." Furthermore, few want a landfill in their neighborhood.

EFFECT OF LANDFILL GASES ON AIR QUALITY AND HEALTH

Odors are always a concern of landfills. In an attempt to reduce odors, modern structures install piping and collection systems for the recovery of gases produced by the breakdown of the wastes.

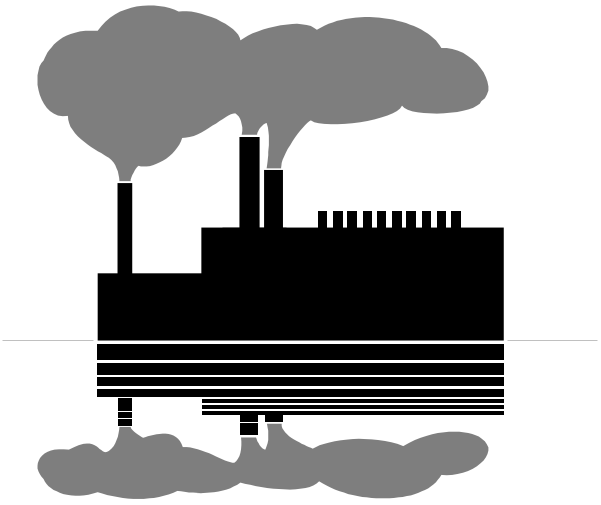
Additionally, landfills risk the possibility of explosion from excessive concentrations of methane (an odorless, explosive gas) as well as the long-term risk of pollution caused by gases escaping into the atmosphere. Since methane comes from the deterioration of organic matter within the landfill, the natural decomposition process over time will result in buried waste giving off methane and water.

Furthermore, the production of methane pockets can continue at a landfill for 10 to 20 years after collectors bury the solid waste products. Because methane is heavier than water, it accumulates and seeks the lowest point. Its accumulation and subsequent migration can result in explosions in low built structures such as sewers and basements of buildings.

CONTROL OF WASTE VOLUME

Communities can control waste volume through **recycling**, **source reduction**, and incineration. However, to make such controls work, consumers must be willing to separate recycled goods and reusable containers, and they must be willing to purchase recyclable products and products made from recycled goods. Otherwise, recycled and/or recyclable products will not survive in a competitive enterprise economy.

Although, incinerators can reduce waste volume and kill bacteria in wastes, their **ash** and **air emissions** can be problematic. Communities must educate their citizens on the technological advances of incineration if they desire community acceptance and cooperation. Furthermore, through the use of established emission standards, community leaders must strictly enforce or regulate the amount of pollutants that landfills or industry discharge into the atmosphere.



Recycling

There are several definitions of recycling waste.

- The commonly accepted meaning is to use discarded materials in their original or changed form rather than wasting them.

- The precise meaning refers to sending material back into the process by which industry first formed it.

- The general meaning refers to the separation of recyclable materials such as newspapers, cardboard/corrugated papers, plastics, glass products, or metals (aluminum, steel, tin, etc.) from the waste system at the point of generation (households, industries, etc.). This also includes the separation and recycling of materials from municipal waste by individuals or specially designed recovery facilities, industrial in-plant recycling, and/or recycling by commercial establishments. Source separation makes recycling simpler and easier.

A successful recycling program must consider the needs of the entire community. Although different communities have different sets of priorities, the following three-step process can apply to any recycling effort.

1. Collect waste materials that have potential value. Collection methods include voluntary measures such as drop-off or curbside service, mandatory curbside service, or private collection (when citizens or firms pay private operating agencies to collect the solid waste — also known as private disposal).

2. Sort or process the above waste materials to a condition useful for industry.

3. Market those materials to industry for manufacture of a useful end product. This step is key to the recycling process. If there is no market to buy the product, recycling

cannot be successful and the community would have to dispose of the recycled goods in another manner after collection.

Many citizens share a common concern for wanting to protect the environment; however, they are uncomfortable with mandatory recycling for two reasons. First, it takes some effort to separate the materials. Secondly, once recycling becomes mandatory within a community, lawmakers may have to impose fines or penalties for those people who do not comply.

Source Reduction

Source reduction is the process of keeping waste out of the waste system through buying practices, conservation, etc. However, source reduction does not by itself solve a community's waste disposal problems.

Communities frequently resort to a combination of options, especially since they must landfill the residue of recycling and take incinerator ash to a landfill for disposal. Therefore, an alternative such as landfill disposal is important even when communities use source reduction and other options.

DID YOU KNOW?

According to the EPA, from 1980 to 1990 the average yearly increase of garbage discarded by each American was 69 pounds.

REAL ENVIRONMENTAL RISKS OF AN INCINERATION SYSTEM

Incineration is an option that communities should consider only after they have explored recycling and source reduction. The remaining trash must go somewhere, and landfill space is becoming increasingly limited in certain communities. The main point of incineration is to reduce consumption of landfill volume.

Often, because of the NIMBY factor, communities do not readily welcome large waste burning facilities. Residents associate landfills with chronic **toxicity** problems (conditions which structures can easily correct with liners), as well as the previously mentioned air pollution and odor concerns.

Even though disposal facilities eliminate 70 to 90 percent of the solid waste volume, communities must landfill the remaining ash. Ash is the residue that remains after a landfill has burned a fuel or solid waste, which consisted primarily of non-combustible materials. The incineration process produces two types of ash: filter (or "fly") ash and bottom ash.

- Fly ash is all solids (including ash, charred papers, cinders, dusty soot, or other matter) that rise with the hot gases from **combustion** rather than falling with the bottom ash. Fly ash is only a minor portion (or about 10 percent) of the total ash produced from combustion of solid waste, but environmentalists consider it to be more toxic than the cinders and metal bits of bottom ash.

- Bottom ash is the non-airborne combustion residue from burning fuel in a boiler. The ash falls to the bottom of the boiler and landfills remove it mechanically. Bottom ash constitutes the major portion (or about 90 percent) of the total ash created by the combustion of solid waste.

The most common types of incinerators are mass-burn plants, refuse-derived fuel facilities, and modular small units (or other types of combustors).

- *Mass-burn Plant*: Takes virtually all non-hazardous waste and burns it collectively.

- *Refuse-derived Fuel Facility*: Separates, crushes, and **pelletizes** waste for burning alone or with fossil fuel.

- *Modular Small Unit*: Includes a variety of different combustion technologies.

Communities currently dispose of ash by mixing truckloads of fly and bottom ash with truckloads of unburned wastes at municipal solid waste landfills. Although these landfills usually do not attempt alternative processing methods to contain the toxic materials found in the ash (leading to potential health problems), governmental agencies are classifying such airborne emissions of gases and toxic chemicals as hazardous under the *Clean Air Act.*

Cost is another factor in using incineration. As of 1990, incineration costs range from $40 to $90 per ton, translating into an additional $30 to $40 per household each year.

JOINING AN ENVIRONMENTAL GROUP

April 22, 1995, marked the 25th Anniversary of Earth Day. Environmental groups from across the country celebrated their accomplishments and pointed to the challenges ahead. These groups range from very large — the Nature Conservancy and Sierra Club — that take on a wide range of environmental efforts, to the smaller, local groups that usually fight more defined battles. They also range from all-purpose to single-minded, from wealthy to poor, and from compromising to confrontational.

While deciding if you want to join any of the dozens of environmental groups, ask yourself, "What does the group really do?" "What level of commitment do I plan to give — time, money, or both?" and, "What will the group expect from me?" Some groups may want you to simply make telephone calls or write letters, whereas others may want you to become involved in environmental restoration projects where you roll up your sleeves and grub around in the soil, muck, and briers.

Whether you join a group or not, remember that environmentalism should start in each person's backyard, grow to consume a neighborhood, and finally, expand until it encompasses the entire community. Frequently, however, the disappointments of these groups outnumber the rewards. Yet, there are many unsung groups that fight difficult bureaucratic battles without drawing much praise. The following is a sampling of national environmental groups:

Defenders of the Environment
Earth Alliance
League of Conservation Voters
Legal Environmental Assistance Foundation
Nature Conservancy
Sierra Club (includes the *Sierra Club Legal Defense Fund*)

CASE STUDY

The city of Grenada has a population of two million people. It has reached a solid waste crisis.

Trashmore, located on the south side of Grenada, is the larger of two solid waste landfills. It accepts over three-fourths of the city's solid waste and has disposal capacity for ten more years. This landfill has existed for 25 years, long before there were any environmental laws governing landfill disposal. Therefore, in addition to household garbage, it also has handled many substances that the government now considers to be hazardous. Trashless, the city's smaller landfill, has reached its capacity. Grenada does not have a recycling program.

Less than three miles from Trashmore is the Grenada River, which is the city's primary source of drinking water. However, a serious drinking water problem exists for the city. Governmental inspectors have discovered that the Trashmore facility does not have a protective liner, causing hazardous substances from the landfill to contaminate the groundwater.

Additionally, residents have reported isolated cases of uncommon illnesses in the area of the landfill, but it is uncertain if the illnesses are the result of the emission of methane gas.

State and federal environmental agencies have contacted the Grenada city council regarding these environmental problems. The council must decide what course of action to take to solve the city's problems. It must exercise one of the following options:

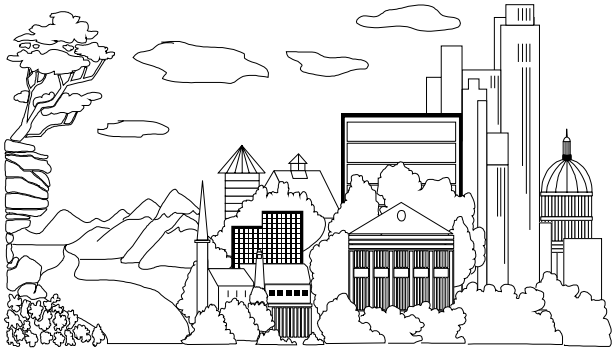
1. Keep Trashmore open since it has the additional capacity.

2. Build a new state-of-the-art landfill.

3. Contract with a commercial disposal facility elsewhere in the city, either temporarily or permanently.

4. Build an incinerator to burn the solid waste.

5. Develop a recycling program. (Consider this option in conjunction with any one of the above options.)



Next, the city has to control and clean up the contamination to the drinking water supply by treating the water with chemicals. This means they must also select a location for and build a new water treatment facility. In the meantime, the city must provide enough drinking water to its citizens, which is a very costly undertaking.

Finally, the city council must deal with its air pollution problem by controlling the methane gas emissions. The council may also want to consider decreasing the use of cars within the city limits. Regarding the air pollution, the city should consider using alternative fuels. For the vehicle problem, one option the council should consider is to create High Occupancy Vehicle (HOV) lanes. These lanes encourage carpooling, thereby reducing the number of vehicles on the road.

The city council is holding a town meeting to consider the options for solving their environmental problems. There are citizens in attendance who have varying opinions on these issues. Many citizens oppose the community locating any facility in their neighborhood. The residents of Southside are particularly strong in their opposition.

Imagine that you are a city-council member. Using the information provided in this lesson and the background information given with the case study, what would you select as the best option for Grenada's landfill problem? Remember that you must also consider the city's water and air pollution problems when determining the best possible course of action. Use the problem-solving/decision-making models to assist you throughout this case study. Be prepared to present the option you select with your reasons to your JROTC instructor.

THE FUTURE: TWO EXAMPLES OF WHAT TO EXPECT

MAN-MADE LIGHTNING

Man-made lightning, **searing** at up to 18,000 degrees, will soon turn hazardous (toxic) and municipal wastes into harmless blocks of glass at a fraction of the cost of current disposal techniques. The process would transform much of the nation's garbage and poisonous waste into paving material. Plus, gases from this process would be about a tenth of that from conventional incinerators.

Continuous bolts of artificial lightning would arc across a nitrogen-filled furnace chamber to create a superheated plasma that would melt most waste products and neutralize molecules of highly toxic chemicals. The electrical charge and high temperatures of the furnace would blow apart toxic chemicals such as solvents, causing the atoms to recombine into simpler, less toxic, and more manageable molecules.

METHANE USED AS FUEL FOR POWER PLANTS

Methane is a basic ingredient of natural gas and the fuel for stoves, water heaters, and industrial machines like power plants. Since rotting garbage in landfills naturally creates methane, about 150 landfills nationwide (in 1998) sell methane. Pipes are inserted into hills of rotting garbage at landfills to collect methane, which is then cleaned of water and grit, and pumped to power plants.

For example, in Orlando, Florida, the Orlando Utilities Commission power plant plans to use methane from the county-owned landfill to supplement its coal-burning plant. The methane will provide electricity to 13,000 homes. In this way, the county benefits because it receives payment for the landfill methane from the power plant. The power plant, in turn, benefits by reducing its fuel costs, and the environment benefits because landfill methane is not released into the atmosphere.

CONCLUSION

Governmental agencies from the local level up to the U.S. executive and legislative branches must constantly be alert to the growing environmental problems that face our nation. Then, they must create and enforce pro-environmental legislation to fight those problems. However, saving the environment is not just the government's responsibility.

All Americans must become more sensitive to environmental issues and determine what they can do to help. After all, environmentalism begins in everyone's backyard — it is everyone's responsibility to preserve and protect the environment in which we live.

* * *

GLOSSARY

A

acid rain. Acid pollution in the form of wet or dry precipitation caused by the combination of sulfur dioxide, various oxides of nitrogen, and atmospheric moisture.

aiming off. An orienteering method by which the navigator aims to one side of a destination point instead of directly at it. This produces certainty that after the distance is covered the target point can only be in one possible direction.

air emission. A solid particle (such as unburned carbon), gaseous pollutant (such as nitrogen or sulfur), or an odor that is emitted into the atmosphere as a result of a broad variety of activities including exhaust from vehicles, combustion devices, landfills, compost piles, street sweepings, excavations, demolitions, etc.

air navigation. The study and practice of navigating (planning, recording, and controlling the course and position of) an aircraft.

altimeter. An instrument in aircraft that measures altitude, the distance above the horizon.

arc. Anything shaped like a curve, bow, or arch; a curved line.

ash. The residue that remains after a fuel or solid waste has been burned, consisting primarily of non-combustible materials.

attack point. An easy-to-find landscape feature shown on the map from which the final approach to a control may be made.

atheist. One who denies the existence of God or any supernatural being.

automation. Controlled operation of equipment or a system by mechanical or electronic devices that take the place of human labor.

azimuth. A horizontal angle usually measured clockwise in degrees from a north base line (direction).

B

back azimuth. The opposite direction of an azimuth obtained by adding 180 degrees to or subtracting 180 degrees from an azimuth.

bar scale. A ruler used to measure actual ground distances by converting distances on a map.

beeline. A course which travels in a straight line across the map.

bench mark. A surveyor's mark made on rocks or other permanent objects to indicate known elevations.

Buddhist. A follower of Buddhism, a religious and philosophical system based on the teachings of Guatama Buddha who rejected certain Hindu beliefs, particularly the caste system.

C

cardinal direction. The four principal points of the compass, or intersections of the horizon with the meridian and the prime vertical circle: north, south, east, and west.

Catholic. A follower of the Roman Catholic Church, a Christian church which accepts the absolute authority of the pope on decisions of faith and morals.

Celtic. Pertaining to the Celts, an ancient people who dominated Europe in the 4th century B.C. and eventually withdrew to the British Isles.

center of mass. The point closest to the middle of an object.

Christian. Relating to a religion based on the life and teachings of Jesus Christ, who followers of the religion believe to be the Son of God.

clans. Groups united by common interests or characteristics, particularly Celtic groups in the Scottish highlands claiming descent from common ancestors.

collective. Suggesting a number of people or things considered as a whole based on similar or shared characteristics or interests.

combustion. A burning; a chemical exchange, especially oxidation, accompanied by the production of heat and light.

commonwealth. A group of self-governing countries loosely associated in a common allegiance.

composting. The controlled biological decomposition of organic solid waste into soil amendments such as mulch under aerobic (in the presence of oxygen) conditions.

concave. Curving inward, as the inside of a bowl.

concentric. Having a common center.

Confucianism. A moral and religious system of China that does not teach the worship of a god or the existence of life after death, but is a guide to ethics and government based on sympathy or "human-heartedness" with others through ritual and etiquette.

continent. Any of the seven large landmasses on the planet.

contour interval. The difference in height, or elevation, between one contour line and the one next to it on a topographic map.

contour line. A line on a map that connects equal points of elevation.

contrast. To show differences when compared.

control points. A trapezoid-shaped marker (usually orange or red and white) used to mark features on an orienteering course, usually with clipper or control punch attached to mark a control card as proof of arrival.

convex. Curved outward, as the outside of a circle or sphere.

coordinate scale. A tool for plotting grid coordinates on a map.

cordillera. A system of mountain ranges often consisting of a number of parallel chains.

cultural feature. A manmade feature depicted on maps; for example, a road, railroad, dam, bridge, etc.

cut. A man-made feature resulting from the removal of high ground, usually to form a level area for roads or railroad tracks.

D

declination. An angular difference between true north and either magnetic or grid north.

deforestation. The act of clearing forests, often to earn income from timber, create farmland, or expand urban areas; may result in the permanent loss of forest areas and soil erosion.

degree. A unit of latitude or longitude, equal to 1/360 of the globe.

depression. A sunken or low place in the ground.

desertification. A process in which fertile land is turned into desert, usually due to overuse of the land and/or inadequate rainfall.

dominion. A self-governing nation of the British Commonwealth, other than the United Kingdom, that acknowledges the British monarch as chief of state.

draw. A less developed stream course than a valley.

E

equator. An imaginary line at 0 degrees latitude that circles the globe at its widest point halfway between the North Pole and South Pole.

ethnicity. Of or relating to large groups of people classified by racial, national, religious, linguistic, or cultural origin, or by background.

F

famine. An extreme scarcity of food resulting in the starvation of many people.

field-expedient. Adapting to a particular situation by using available materials and/or resources.

fill. A man-made feature resulting from raising a low area, usually to form a level area for roads or railroad tracks.

fjords. Narrow inlets of the sea between cliffs or steep slopes.

fragmented state. A discontinuous country whose national territory consists of two or more individual parts separated by foreign territory and/or international waters.

G

geysers. Natural springs that periodically eject fountains of heated water and steam from a crack in the earth's surface.

globe. A sphere-shaped model of the earth.

Greenwich Mean Time (GMT). The time of day at any given moment at Greenwich, England. GMT is noted on communications and teletype reports as "Z" or "ZULU" time, in accordance with the international phonetic alphabet.

grid. A pattern of intersecting parallel lines used to divide a map into small squares.

grid coordinate. A set of letters and numbers specifying the location of a point to the desired position within a 100,000 meter square.

grid lines. Lines that are regularly spaced at 1,000 or 10,000 meter intervals that make up the grid on a map.

grid north. The direction of north that is established by using the vertical grid lines on a map.

grid square. The intersecting of north-south and east-west grid lines at 90-degree angles to form a square.

grid zone. One of the 60 north-south divisions of the earth's surface between 84 degrees north latitude and 80 degrees south latitude, each six degrees wide.

Gulf Stream. A warm ocean current that originates in the Gulf of Mexico, flows along the east coast of the U.S., then across the Atlantic Ocean as the North Atlantic Drift; its warm water helps moderate the climate of northwest Europe.

H

hachure. A short broken line used for showing relief on a map.

hemisphere. Half of the earth, as in the Northern hemisphere, Southern hemisphere, Eastern hemisphere, or Western hemisphere.

Hinduism. The chief religion of India characterized by individual worship rather than congregational, devotion to many gods, belief in reincarnation, and the caste system (inherited social rank with strict rules governing each class of people).

homogenous. Of the same or similar nature; uniformity of structure or composition.

hydrographic feature. An ocean, coast line, lake, river, stream, swamp, or reef portrayed by tinting or blank spaces on a map.

I

ideological. Pertaining to the way an individual, group, or culture thinks about economic, political, or social concepts.

incineration. An engineered process involving combustion to thermally breakdown organic waste materials.

intermittent. Alternately stopping and starting; coming at intervals.

intersection. The method of locating an unknown point by determining where the azimuths from at least two (preferably three) known points meet (intersect).

Islamic. Relating to Islam, a religious faith that includes belief in only one God (*Allah* which is Arabic for God), Mohammed as his prophet, and the *Koran* as the word of God; followers of Islam are known as Muslims.

isthmus. A narrow strip of land connecting two larger land areas.

J

Judaism. The religion of the Jewish people developed among ancient Hebrews and characterized by a belief in one God and the eventual coming of a Messiah to rule Israel and the world.

L

landfill. A system of trash and garbage disposal in which waste is buried between layers of earth to build-up low-lying land; the waste disposal facility that uses this system.

landform. A natural or man-made feature on the earth's surface.

latitude. The angular distance north or south of the earth's equator, measured in degrees along a meridian, as on a map or globe.

leachate. A solution or product resulting from precipitation filtering or sifting through a pile of solid materials which contains water, dissolved solids, and decomposed products of solids.

legend. An explanatory description on a chart, map, or other illustration.

linear feature. A straight road, railroad, power line, etc., which can be followed from the air.

longitude. Lines that run from the North Pole to the South Pole and are equal in length on a map or globe.

M

magnetic azimuth. A direction that is expressed as the angular difference between magnetic north and a line of direction.

magnetic north. The direction to the north magnetic pole, as indicated by the north-seeking needle of a magnetic instrument.

man-made. Manufactured, created, or constructed by man, rather than formed by nature.

map. A line drawing, to scale, of a portion of the earth's surface, as seen from above.

marginal information. Instructions placed around the outer edge of a map.

mean sea level. The position of the level of the surface of the sea midway between high and low water.

meridian. An imaginary circle on the earth's surface passing through the North and South Poles; a line or parallel of longitude.

methane. An odorless, colorless, flammable gas that can be formed by the anaerobic (in the absence of oxygen) decomposition of organic waste matter or by chemical synthesis; it is the principal component of natural gas and landfill gas.

mil. A unit of measure that expresses the size of an angle formed when a circle is divided into 6,400 angles with the vertex of the angles at the center of the circle; one degree equals 17.78 mils.

Military Grid Reference System. This grid reference system is designated for use with UTM grids. The coordinate value of points in these grids could contain as many as 15 digits if numeral alone were used, but the US Military Grid Reference System reduces the length of written coordinates by substituting single letters for several numbers.

monsoon. A wind system that changes with the seasons, especially in the Indian Ocean and southern Asia; heavy rainfall that is associated with this type of wind system.

N

nautical mile. A unit of measurement that is approximately 6,080 feet — which is one minute of latitude; it is slightly longer than a statute mile (see **statute mile**).

nomadic. Living without a fixed location; moving from place to place for trading purposes or in search of pasture and water for livestock.

O

oasis. Fertile areas in the desert where underground water reaches the surface.

ocean. One continuous body of salt water that is broken up by landmasses, given four different names based on where it is divided by continents: *Pacific Ocean, Atlantic Ocean, Indian Ocean, and Arctic Ocean.*

orient. To align or position oneself (or a map) in relationship to one's surroundings.

orienteering. A competitive form of land navigation in which each participant uses a map and compass to navigate between check points.

Orthodox Church. A community of Christian churches that originated in eastern Europe and southwest Asia after separating from the Catholic Church in 1054 over differences in doctrine, including acceptance of the pope's supremacy.

P

pace count. The number of paces required to walk 100 meters. A pace is counted each time the left foot strikes the ground.

parallel. Lines that do not intersect.

pelletize. To form or compact debris into pellets.

per capita. Per person.

pilotage. Landmark flying using charts that give enough details of points on the ground for navigating.

plural state. A country in which there has been extensive contact between two or more national groups without any real cultural mixing.

polar coordinates. (1) A method of locating or plotting an unknown position from a known point by giving a direction and distance along that direction line; (2) The use of either of two coordinates that together specify the position of any point in a plane.

Polar Regions. The areas surrounding the North and South Poles. (See Poles).

Poles. The points on the globe representing the northernmost and southernmost points of the earth, located on each end of the earth's imaginary axis. (See Polar Regions).

pollutant. Any solid, liquid, or gaseous matter that is in excess of natural levels or established standards.

postindustrial. Dominated by production and manipulation of information, skilled services, and high-technology manufacturing.

preflight. Includes planning a flight and making a check of your aircraft.

Prime Meridian. The line of longitude that passes through Greenwich, England, designated as zero degrees longitude, and from which longitude east and west is measured.

prominent. Very noticeable or conspicuous; well-known.

Protestant. Broadly defined, a Christian not of a Catholic or Orthodox Church, including the Amish, Anglican, Assemblies of God, Baptists, Congregationalists, Episcopalians, Evangelicals, Lutherans, Mennonites, Methodists, and Presbyterians, among others. Protestantism began in the 1500s in western Europe as a protest against the Catholic Church.

R

recycle (**-ing**). A procedure of putting waste substances back into productive use, thus reducing the demand on non-renewable resources and preventing problems of pollution and waste disposal.

relief. The shape of land formations on the earth's surface.

representative fraction (RF). The relationship of distance measured on a map to the corresponding distance on the ground; it is usually written as a fraction (e.g., if a map sheet is 1:50,000, RF is 1/50,000).

resection. The method of locating your unknown position by determining where the back azimuths from two or three well-defined locations on a map meet.

ridge. A sloping line of high ground.

ridgeline. A line of high ground, usually with changes in elevation along its top.

S

saddle. A low point between two areas of higher ground.

sear (**-ing**). To burn or scorch with a sudden application of intense heat.

semiautonomous. Largely self-governing within a greater political organization.

Slavs. The largest group of Europeans sharing common ethnic and linguistic origins, including Russians, Belorussians, Ukrainians, Serbs, Montenegrins, Poles, Macedonians, Czechoslovakians, Slovaks, Croats, and Bulgarians.

solid waste. Garbage, refuse, sludges, and other discarded solid materials including those from industrial, commercial, and agricultural operations, and from community activities, but excluding solids or dissolved materials in domestic sewage or other pollutants in water resources.

source reduction. The process of keeping waste out of the waste system through buying practices, conservation, etc.

spatial. In terms of geography, relating to space (area) on the surface of the Earth.

spur. A sloping line of high ground projecting out from the side of a ridge.

statute mile. A unit of measurement that is approximately 5,280 feet (it is commonly referred to as a "mile").

steering mark. An easily identifiable feature in the landscape not shown on the map, and is used by the orienteer to follow a bearing.

sultanate. A country governed by a sultan, the title given to the supreme authority usually of a Muslim state.

superimpose. To place over or on top of something else.

synthetic. Something resulting from synthesis (the formation of a compound from its components) rather than occurring naturally; man-made or artificial; not of natural origin.

T

tectonic plates. Slowly moving plates of the Earth's crust that carry the continents; where two plates meet, one slides under the other, crumpling the crust and producing mountains, volcanoes, and earthquakes.

terrain. A region or tract of land; the character (or topography) of a tract of land.

topographic map. A map that shows relief and the position of natural and man-made features.

toxicity. The level of poison or harm of a particular substance.

true north. A line from any position on the earth's surface to the geographic north pole; symbolized by a line with a star at the apex.

U

Universal Transverse Mercator. (or UTM) A grid system that has been designed to cover the part of the world between latitude 84 degrees north and latitude 80 degrees south, and, as its name implies, is imposed on the transverse Mercator projection.

V

Variation (declination) Angle. The angular difference between any two norths.